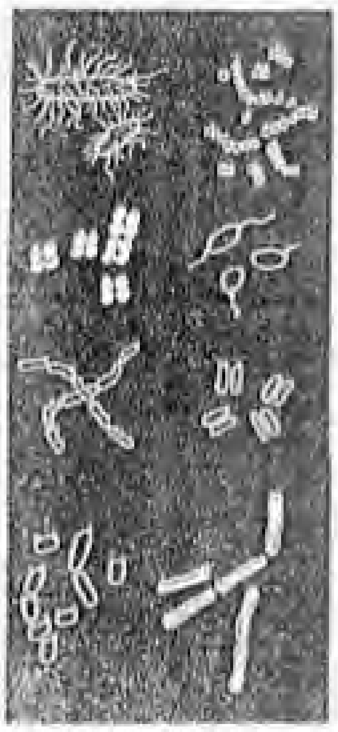
THE SURVIVOR

Volume 6 By Kurt Saxon

MICROSCOPE



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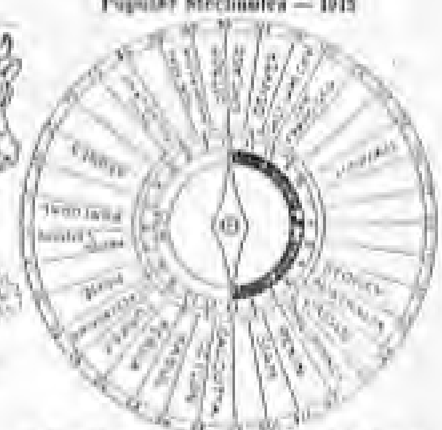

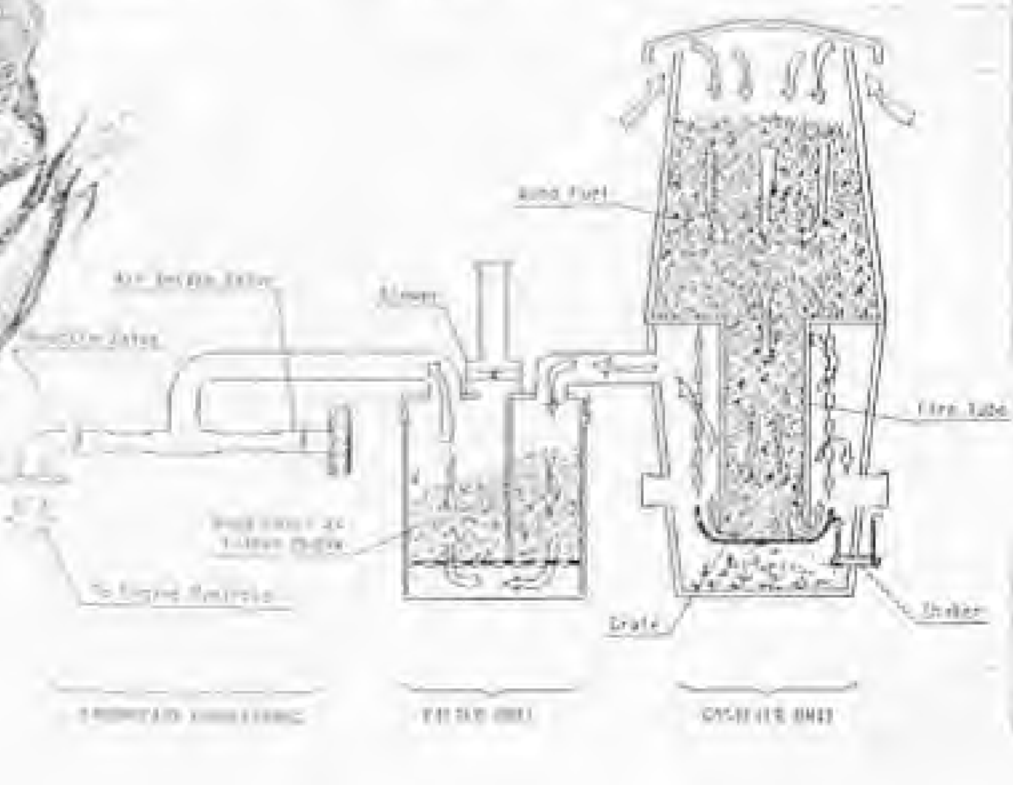

TESTED RECIPES from EL MOLINO KITCHENS

THE SURVIVOR

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CATALOGUE ON BACK PAGES

THE SURVIVOR
Volume 6 By Kurt Saxon

Pickling Your Catch

Some old-fashioned recipes for preserving game fish that are delicious, economical, and simple to follow

By JAN THORNTON

OUTDOOR LIFE

April 1945

FISH PICKLING has many points to its credit, especially at present when food scarcity makes preserving almost a duty. To the sportsman, the pickling of his catch has many advantages. Along with being a money saver, the process is so simple that it can be performed right in camp. And to have one's favorite game fish served in fine style in the off season is a real treat for any fisherman.

Salmon, lake trout, pickerel, pike, catfish, grouper, carp, eels, perch, lake herring, whiting, sturgeon, and buffalo are the most popular fish for pickling. Ordinarily it is best to use dry-meated fish, as they will absorb more pickling solution. This would include such fish as striped bass, red snapper, and pollock. Improvements in pickling solutions, however, have made it possible to pickle practically any and all food fish — including shellfish.

Following is a recipe for pickling fresh-water fish (including catfish) which will take care of 10 lb. of fish:

CAN THE COMING DARK AGE BE PREVENTED? THE DICTATORSHIP OF THE INTELLIGENTSIA

by KURT SAXON

Throughout history the Power Elites have usually been the rulers, the merchant class and the clergy. The rulers want subjects, taxpayers and soldiers. The merchant class wants customers and laborers, preferably cheap labor. The clergy wants worshipers and contributors.

So the rulers want power, the merchant class wants wealth and the clergy wants reverence. Power, wealth and reverence are all basic survival mechanisms. From the Prime Minister to the village Mayor, rulers are guaranteed the best that their level of the system has to offer. The same goes for the industrialist down to the owner of the country store and from the Pope down to the preacher in the country church.

Civilizations are built by hardy, intelligent people. If only hardy and intelligent people were allowed to reproduce, a civilization would never die. It would only grow, through science, technology and wisdom.

Unfortunately, there has always been an underclass to prevent real progress. As a civilization grows, an easier environment provides the means to survive where the underclass could not have survived before. Having more children, on average, than the hardy and intelligent, the underclass outbreeds their betters, swamps the system and the civilization collapses.

But why didn't the Power Elite limit the population of the underclass? In the beginning of the civilization, the rulers were strong; they wanted power to build and grow. They were creative. Those of the merchant class were creative, also in a social sense. They wanted to produce the best so that their culture would be superior to other cultures. The clergy wanted a strong people led by a strong god. The religion was based on strength and purpose for the culture as a whole.

After the civilization was well-established, the Power Elite, usually hereditary, at least by class, was less hardy and intelligent than the Power Elite of previous generations. This is because less aggressiveness is needed to control a more accepting populace.

But as the civilization grew with an accumulation of knowledge and skills, so did the underclass grow in numbers. Whereas the women in the Power Elite always had knowledge of birth control and abortion, women of the underclass were discouraged by the Power Elite from limiting their births.

The Power Elite has always had a vested interest in more citizens. As already stated, the rulers wanted subjects, taxpayers and soldiers. The merchant class wanted customers and laborers and the clergy wanted worshipers and contributors.

As the quality of the Power Elite degenerated, so did the quality of the underclass. The underclass had as many children as biology allowed. Since less intelligence was needed to survive, sexual selection was seldom made on the basis of the ability of the male to provide or the female to nurture.

So, in time, the civilization was headed by self-serving incompetents and not

Vinegar (distilled)*	2 qt.
Water	1¼ qt.
Allspice	1 oz.
Red pepper	1 oz.
White pepper	1 oz.
Mustard seed	1 oz.
Bay leaves	½ oz.
Onions (sliced)	½ lb.

**Do not use fruit or cider vinegars or your pickled fish may acquire a foreign taste. Be sure to use fresh spices—whole ones if possible.*

Clean fish carefully, skin, remove backbone, and cut into average serving portions. Soak for 1 hour in a brine of 1 cup salt to 1 gal. water, to remove blood. Have a clean earthenware crock ready (do not use metal or wood) large enough to accommodate amount of fish to be pickled. After draining fish, pack it carefully in the crock (always pack pieces on end), then cover them with a saturated salt-solution brine. This brine is made by placing a fresh egg at bottom of water and pouring in salt until egg floats (90-degree brine).

Leave fish in this brine for 12 hours, then rinse in fresh water. Clean crock thoroughly of all brine sediment. The fish is now ready for packing. Grind and mix all spices, sprinkle a small amount on the bottom of the crock, then pack in a layer of fish. Place a layer of sliced onions on top of fish. Repeat this process, sprinkling each layer with small amount of mixed spices, and garnishing with onions, until the crock is filled to within a forefinger of the top.

Cover fish with 1 part water to 2 parts vinegar, mixed beforehand. Add a small piece of alum. Place crock over fire and boil slowly. When fish can be pierced with a fork easily, remove from fire and cool. If pickling is done at camp, the cooked fish can be stored in a cool dry place, and later taken home and packed in pint preserving jars. But be sure that the camp crock cover is kept weighted down with stones.

Do not put fish up in jars of more than 1-pt. size, and remember that a jar with a wide mouth and short neck will make it easy to pack the fish upright. The vacuum or self-sealing mason jar is best for fish preserving. Never pack fish in a jar with an all-metal cover, or in the zinc screw-cap type with porcelain lining, as the possibility of spoilage and food poisoning is very great. The glass-top mason jars are second-best to the vacuum-sealed ones, and may be safely used.

To pack fish in jars, remove from crock, and do not throw away the vinegar solution. To each jar add a few pinches of fresh spices and two bay leaves. Place a slice of lemon against the inside wall of the jar, and two slices of onion on top. Strain the vinegar solution and pour the clear liquid over the fish. Close jars tightly. If stored where it's cool and dry and dark, these pickled fish will keep for from 4 to 8 months. The quality of the fish and the pickling ingredients will determine the goodness of the finished product.

only overpopulated, but swamped by the simple-minded. Ur of the Chaldees, Babylon, Egypt, Greece, Rome, Constantinople, etc.---. Overpopulation and down-breeding.

The Soviet Union is a good example for our time. Most of the Third World countries, propped up in their hopelessness by the industrial nations over the last several decades are hardly worth fitting into the pattern. The U.S. and Western Europe do fit the pattern and their fall will put a finish to world civilization as we know it.

The collapse of world civilization is a mathematical certainty. Around 1850, for the first time in history, world population reached one billion. Only 80 years later, in 1930, it doubled to two billion. Then by 1975, only 45 years, it doubled again to four billion. Now, in 1999, it is over 6 billion.

Our species has become a plague on the land. It threatens nearly every other species. Worse still, the lack of selection has caused down-breeding which has overrun the Earth with mediocrities at best and idiots at worst. Nearly 50 million Americans are functional illiterates. Also, 30% of American births are illegitimate. In 1960 it was only 5%.

America has 36 million Welfare recipients and 44 million on Social Security. There are about 20 million Federal retirees. Counting prisons, mental institutions, etc., the U.S. has over 100 million social dependents, called "Entitlements" out of a population of 270 million. The rest of the developed countries are worse off. The Third World systems are hopelessly dependent on us, doomed after our fall.

Many who have a vested interest in our system deny the consequences of overpopulation and down-breeding and some even deny overpopulation and down-breeding, as such. They cite technological, economic and scientific progress as proof that all the world's problems can be solved with the proper application of existing knowledge.

The main theme of Rush Limbaugh, for instance, is that our system is sound. It just needs reprogramming to bring it back to the health of the "Leave It To Beaver", "Father Knows Best" era of the 1950's. But in the 1950's the population of the U.S. was around 140 million and the average I.Q. was ten points higher than today. There were few social dependents and, as stated earlier, the illegitimacy rate was only 5% as opposed to nearly 30% today.

Elmer Pendell, in his book, "Why Civilizations Self-Destruct", wrote, "In our own civilization we see a lessening of the struggle for survival. Welfare does away with natural selection.

"Being, in part, an accumulation of skills and know-how, of buildings and tools, of transportation and communication, civilization must necessarily lag behind the concentration of brain power on which it depends. And since the visible forms and structures of a civilization are an accumulation, they may endure for decades after average intelligence has declined far below the level required to create the civilization." And, I might add, "Maintain the civilization".

In a sense, we are living in a kind of Disneyland for dummies. Most people see only the progress and deny the regress. Blaming that on a natural phase, soon solved by revamping our political and economic structures.

This is wishful thinking by those locked into a doomed system. Rather than face up to the coming collapse and loss of their present way of life, they ignore the warnings and will continue to do so until it is too late for them.

It is natural to ask for signs of the coming collapse and especially for a time frame. Predictions are troublesome since unforeseen developments can delay or hasten breakdown. But overall, debt is the best indicator.

When a person is in debt and can't pay, he can lose all he has and may face starvation, unless he has a backup system such as Welfare or relatives. Nations are much the same. When a national debt grows beyond a people's ability to pay, the country goes into default. Without backup by other nations, the country sinks into civil war, revolution, famine, etc.

For decades, the U.S. has been propping up bankrupt nations. What happens when it becomes ouR turn? It is a certainty, then, that the propping up of other nations will stop. Then world civilization will end.

When the U.S. goes, the rest of the world will follow. Riots, wars, starvation,

One of the best and oldest sorts of pickled fish is known as *escabeche*—an old Spanish dish that dates back to Roman times. Kingfish, tuna, pompano, mackerel, and bluefish are fine for this recipe, although any salt-water fish of firm texture may be so pickled. Avoid all soft-fleshed fish. Recipe:

Vinegar (distilled)	1 qt.
Red pepper	1 tbsp.
Black pepper	1 tbsp.
Bay leaves	2 tbsp.
Cumin seed	½ tbsp.
Marjoram	½ tbsp.

Cut fish in serving portions, and wash thoroughly. Drain, and let soak in a 90-degree brine for ½ hour. Then wipe dry with clean towel. Pour olive oil in hot frying pan together with a few red peppers, six bay leaves, and a clove of minced garlic. Fry fish in this until a light brown color; remove and lay aside to cool. Keep the oil hot in frying pan for following sauce:

Cook three medium-size sliced onions until yellow, then add marjoram, cumin seed, whole black pepper, and vinegar. Cook this slowly for 20 minutes, then let cool.

Now sprinkle fish with the remainder of the red pepper and bay leaves, and pack in sterilized pint jars. Fill each jar with the cooled sauce and place top on tightly. As with many preserved foods, age improves this pickled fish, and it will last a month in the summer and six times longer in cooler weather. Store in a dark, cool, dry place. This recipe will pickle 10 lb. of fish.

Spiced fish can be prepared in three ways. It can be preserved in jars with spiced vinegar, after being properly prepared; it can be cooked and placed in spiced vinegar for immediate eating; or it can be pickled in crocks so as to last for a week or more. Shad, lake trout, mackerel, and salmon are the best fish for spicing. A good spiced-vinegar sauce that will add new flavor to your catch is the following:

Vinegar (distilled)	2 qt.
Water	1 qt.
Sugar	2 oz.
Mustard seed	½ oz.
Whole cloves	¼ oz.
Whole white pepper	¼ oz.
Cracked whole ginger	⅛ oz.
Cracked cardamon seed	⅛ oz.
Bay leaves	⅛ oz.

Mix sugar and water and add to vinegar. Place all the spices in an unbleached cotton bag and put in liquid. Allow this mixture to simmer for 1 hour. Strain through cheesecloth and use the clear liquid in pickling crock. This can either be poured over your cooked fish 4 or 5 hours before eating, or used as a preserving agent for putting the fish up in jars.

Potted trout is excellent when pre-

plagues, will take up to 80% of the world's population.

But let's say the powers that be come up with the interest this year without stripping the Entitlements. What of next year, or the next? Consider, the projected interest due in the year 2000 is one trillion, five hundred and twenty billion; probably much more. The overall population will have grown, as well as the population of ungovernable dimwits and criminals. So the total and irreversible collapse of our system is, indeed, a mathematical certainty.

Our species will probably survive. But how long will it take to recover from the ruin brought on by the most widespread collapse in history?

When a power collapses it leaves a power vacuum. That power vacuum is often filled by a numerous but incompetent body of want-to-be's. When Rome degenerated, weakened and collapsed the power vacuum was filled by the early, primitive Christians. This led to a period marked by ignorance and terror known as the Dark Ages.

When a civilization loses it's vigor, even if it doesn't actually collapse, it becomes weak and ripe for revolution. Revolution, even a seemingly peaceful one, can produce changes just as radical as the Dark Ages were to the formerly ordered and disciplined Rome.

The French Monarchy, weak and corrupt, was taken over by a mob of ignorant rabble. Czarist Russia, degenerate, corrupt and weak, fell first to the Socialists then to the Communists. Germany's Weimar regime, weakened mainly by America's Great Depression, fell to Hitler's National Socialists. Neither Russia nor Germany have recovered from their respective revolutions.

From 1346 to 1350, the Black Plague ravaged Europe. It killed over half of Britain's population and a third on the Continent. Due to the less sanitary conditions among the underclass, they were nearly exterminated. This also lessened the power of the Church.

Without the underclass to do the labor, the intelligent of the upper class set about inventing labor-saving devices. Freed from the repression of the Church, the European mind flourished. Science, art, mechanics, literature, philosophy, music, all came alive. This was the Renaissance. Then came the Industrial Revolution.

This was creativity by the men of intellect. They had the real power. But they were dominated by their inferiors, men who wanted power for power's sake and reverence for the sake of a life of ease without effort.

Imagine the kind of world we might have if the intelligentsia, beginning during the Renaissance, had joined forces. They had no way to do this, of course. But had they had a way of pooling their knowledge and consolidating their power, the tyrannical, the avaricious and the pious frauds, could not have brought our present world civilization to the verge of ruin.

Today there would be space cities orbiting Earth, colonies on the moon and Mars. There would be no surplus population, no threats to the environment, little crime, no wars and very little poverty. On a planet ruled by reason, the prime law would be that anyone could do as he pleased as long as he didn't do it to the disadvantage of others. No child would be born without a reasonable guarantee that it would be well-born, well-reared, well-educated and well-occupied.

In case there is doubt as to what an intellectual is, here is a working definition. An intellectual is one who has an active, searching, reasoning mind. He is secure in the confidence that he can function through his own ability. He doesn't seek security in having a lot of uniformed robots marching at his bidding. He may be wealthy but through his own abilities and not through the deprivation or exploitation of others. Nor does he need the worship and support of fearful suckers.

The intellectual is the brain of every stable system where intelligence is appreciated. But he becomes an endangered species after the collapse of his system and its takeover by political or religious tyrants. Unfortunately, a system's collapse is usually followed by a takeover by political or religious fanatics who feel most secure in an atmosphere of ignorance.

So the collapse of our system will be a real danger to the surviving intellectuals. If the growing lunatic fringe should gain power, the True Believers will liquidate

served with this recipe. Clean trout and cut into pieces long enough to fill pint jar to the neck. Pack in jars and fill with this spiced-vinegar sauce. Tie a piece of muslin over the top of each jar. Set jars in a pan of water, and bake in a slow oven for 2 hours. Remove cloth, and pour on enough melted wax to make top airtight. Store in a dark, cool dry place. Whiting, perch, salmon, pike, shad, and pickerel may be prepared the same way.

Cod, smelts, mussels, shrimp, clams, oysters, roe, and alewives make good pickling. Steamed or baked carp and mackerel also make a fine dish when placed in a crock of spiced vinegar for 24 hours after cooking. And left-overs of all game fish can be placed in the spiced-vinegar crock to be saved for salads or sandwiches. Try it sometime!

Red peppers, garlic, and onions can be raised in your own garden; also four valuable herbs—marjoram, fennel, parsley, and dill. A fifth is tarragon, which makes an excellent vinegar. All five can be grown in just a small patch.

Garlic vinegar, excellent for many fish dishes, can be made by placing 5 or 6 crushed cloves of garlic in 1 pt. distilled vinegar, and allowing it to stand for 6 or 7 days. Strain through cheesecloth, and bottle.

Try pickling your extra fish the next time you go camping. All necessary supplies for the first stages of pickling can be carried in the crock, and the fish, all ready for the jars, can be carried home in the same receptacle.

The sharp tang of cedar smoke, the clean smell of fresh-cut pine branches, the fragrance of the bubbling coffeepot—add to these nostalgic breaths from the out-of-doors, the rare perfume of spiced fish steaming on your camp fire.

anyone who can read without moving his lips.

Intelligent people have three basic reasons for preparing to survive. The first, of course, is survival itself. The second is to prevent domination by the kind of religious and political fanatics even now preparing their own kind to take over. The third, and most important, is to rebuild on the ruins and to establish the Dictatorship of the Intelligentsia.

The term may have some offensive connotations. However wouldn't dictatorship by scholars and scientists be preferable to dictatorship by fools and another Dark Age?

One might ask what kind of system would be established. But that would be the wrong question. It really wouldn't'l matter. The idea is to upgrade our species by eliminating the parasites and predators. Without them, with only well-motivated, intelligent citizens, a system of order and liberty will evolve naturally.

Nor should anyone imagine rounding up millions of defectives and doing away with them. The great majority of the underclass will die in the chaos. Then it will only be a matter of sterilizing those parasites and killing those predators left, as they show themselves for what they are, thereby eventually ridding our species of it's underclass.

Now is the time to prepare for the greatest social breakthrough in history. Now is your chance to help inaugurate the next step in the evolution of human civilization.

There has never before been such an opportunity. But if the usual kind of Power Elite gains a foothold after the collapse, the chance may never come again. This is the first time in history the machinery has been in place for intelligent people worldwide to be in contact. With the Internet, CompuServe, computer bulletin boards, etc., the people of intellect can organize, prepare and consolidate.

But first comes individual security. A voice out of the crowd is simply a voice. The individual must start with a means of providing for himself and his loved ones and, hopefully, a way to be an asset to his community. Also, the security of his person, his possessions and his community must be a consideration.

Atlan Formularies, in anticipation of these needs, has been producing works on self-sufficiency and personal security since 1976. These works include The Survivor series, 19th and early 20th century science and technology, thousands of formulas and processes, trades, crafts, cottage industries, etc. These will enable anyone to maintain a pleasant, productive lifestyle during the coming troubles and beyond.

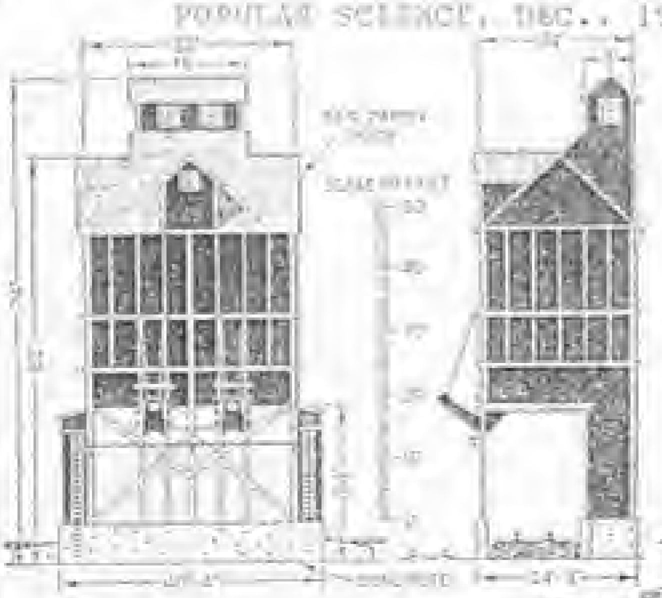
POPULAR SCIENCE MONTHLY JUNE, 1936

CAMP AND PICNIC MEALS COOKED ON TIN CAN

AN OLD tin can is all it takes to make this camp stove, the top of which serves as a bacon, egg, or pancake griddle. It is equally useful in your own back yard, on the beach, in the woods, or by the roadside. And in any of these places, it will give you a thrill to se-

Wheat cakes, bacon, eggs, hamburger, fried bananas, and many other dishes may be cooked

POPULAR SCIENCE, DEC., 1938



Full-size dimensions in feet are given for convenience in working to any desired scale

Building a Coal Chute for a Model Railway

NO ENGINE yard of a model railway layout is quite complete without a coal chute. The foundation of this model is built up of wood blocks. The walls are cut from Bristol board or heavy cardboard and erected with small pieces of wood cemented inside the corners for strength. The roof is made in the same manner. The two chutes are thin metal, bent to shape and soldered. The track for the delivery of coal is 3' to scale higher than the other tracks and runs over a concrete pit inside the building. The building is painted black, and the roof to represent tar paper, while the foundation should be the color of concrete. Mount a flood light on a tall pole nearby.—HAROLD A. SCHUPP.

move steaming, golden brown pancakes from this homemade stove.

The can may be prepared at home, but if you wish to conserve space and are planning to have canned fruit for your outdoor meal, just take along a can opener and tin shears or other tool for cutting two openings in the cylindrical side of the can. A one-gallon can is the most effective, but a two-quart tin will do. If you don't buy in such large quantities, a suitable can may be obtained from any hotel or restaurant.

To make the stove, completely remove the top of the can, but leave the thick edge A around the top. This end of the can will be placed directly over the fire. Then cut opening B in the cylindrical side of the tin just below the thick ridge. This rectangular shaped hole must be large enough to serve as a door through which to feed the fire. In a two-quart can this space should measure approximately 2½ by 3½ in.

On the opposite side of the tin can cylinder and at the other end, cut a smaller square opening C to serve as a chimney. This time cut only three sides and fold the flap back so that it is parallel to the flat surface of the can. In a two-quart container, the opening should be approximately 1½ in. square. When larger cans are used, increase the dimensions of the two openings proportionately.

The fire must be small enough to fit under the can; therefore twigs and small pieces of wood will best serve the purpose. Prepare a good-sized pile of fuel before you light the fire. As soon as the twigs and wood have started to burn, place the stove over the fire. To make the cooking device draw well, place the opening or door in the direction from which the wind is blowing.

After the can is hot, use green leaves or paper to wipe thoroughly the top or griddle before you cook anything. The tin coating on the iron can has a low melting point and as it liquifies, it forms iron dioxide, which is slightly poisonous. However, if you remove this tin coating when it first melts, there will be no danger.

To eliminate the bother of carrying lard, bacon may be used to grease the griddle. This small griddle has been used for cooking bacon, hamburger, fried potatoes, corn fritters, fried eggs, scrambled eggs, cubed steaks, fried apples, pork chops, fried bananas, fried tomatoes, and wheat cakes.—ELISABETH MINER.

Home-Built Instrument

REVEALS WONDERS OF

Polarized Light

By P. RALPH DOWDEN

POPULAR SCIENCE MONTHLY

APRIL, 1936

The specimen is inserted through a slot in the side of the polariscope and viewed through a window at the top

JUST remove the piece of mica from an ordinary lamp or the transparent cellulose wrapping from a cigarette package, place it on the specimen glass of this homemade polariscope, rotate the object slightly, and look through the glass window. You will see the specimen transformed into a mass of brilliant color.

Polarized light—light waves vibrating in one plane instead of in all directions—when passed through certain substances is rotated through an angle that depends upon the wave length of the light used. When white light is polarized and passed through mica, for example, its color components are rotated various amounts, producing a colored effect. The thickness of the specimen controls the color produced, so that designs can be built up with pieces of different thickness. If several layers of mica or transparent wrapping material are rotated on the specimen glass simultaneously, the result is a continuous change of coloring.

The chemist uses a polariscope that is essentially a horizontal glass tube with Nicol prisms made from the clear transparent mineral Iceland spar, a pure form of calcium carbonate. A diagonal cut is made through the crystal, and the surfaces are polished and cemented together again with Canada balsam. Light passed through such a crystal gives two beams, each vibrating in a plane at right angles to the other. One ray is refracted to the side and is absorbed by the blackened walls of the tubular holder, while the other emerges from the Nicol prism as light vibrating in a single plane. Such light is said to be polarized.

In the instrument illustrated, pieces of glass blackened on the back with enamel and placed at an angle of about 57 deg. to a beam of light serve as Nicol prisms. One inclined mirror polarizes the light that passes through the specimen, while the other is necessary to view the resultant colors. The details of construction are given in the drawing.

A porcelain socket and a 15-watt lamp furnish the light. A tin reflector directs the light through a diffuser of 1¾ by 2½-in. ground glass to a pocket mirror that throws the light onto the polarizer. The polarizer and analyzer consist of two pieces of thin picture-frame glass, each 2¼ by 4½ in., enameled black on the reverse side with about four coats or until they appear opaque when held to the light. Strips of ½ by 3/16-in. wood and tin supports are used as shown to hold the various pieces of glass firmly in place before the side of the box is closed. The top is removable so that the lamp can be taken out by withdrawing a wood screw from the block carrying the lamp socket. The interior walls are painted a flat black to prevent unwanted reflections. The outside is finished as desired, and a felt base completes the job.

The polariscope with one side removed to show the arrangement of the various parts

Naphthalene, the substance commonly sold in the form of moth balls, if crystallized from denatured alcohol on a slide glass or other small piece of glass, will produce an interesting colored picture when viewed through this device. Tartaric acid used in the manufacture of Seidlitz powders can be crystallized similarly from water. Photographers' hypo is another substance for examination in a similar manner.

Making and using Mexico's *carne seca*

In this modern version of an ancient method of preserving meat, you use your oven instead of the sun to dry thin strips of seasoned beef.

The leathery result is similar to beef jerky —pioneer nourishment still favored by many hikers, campers, and nibblers. But the primary use of this dried beef, following Mexican tradition, is in the preparation of certain cooked dishes. Two are given here: a sauce for tacos, and a soup.

You can dry the meat well ahead of the time you plan to use it, of course, for it keeps a long time.

The amount this recipe makes is the quantity you can dry in one oven.

Carne Seca (Dried Meat)

- 2½ to 3 pounds top round steak, cut 2 inches thick
- 2 large onions, finely chopped
- 2 teaspoons oregano
- 2 cloves garlic, mashed
- 2 teaspoons salt
- ½ teaspoon coarse-ground black pepper
- ⅔ cup vinegar

Trim and discard all fat and gristle from meat, then thinly slice meat across grain into pieces about ¼ inch thick. In a bowl, mix onion thoroughly with oregano, garlic, salt, pepper, and vinegar. Layer the meat and onion mixture into another deep bowl, pouring the last of the onion-vinegar mixture over the meat. Cover and chill at least overnight (or up to 24 hours).

Arrange strips of meat (shaking off onion) closely together, overlapping as little as possible in shallow rimmed baking pans (this amount will fill 3 pans, each 10 by 15 inches). Dry meat in a very slow oven (200°) for 6 to 7 hours, alternating position of trays in the oven about every 1½ hours (if you only have two racks, you can balance one of the pans on another, arranging so air can circulate). When meat has turned brown, feels hard, and is dry to touch, remove from oven, let cool, then store airtight in plastic bags.

Keep at cool room temperature or in the refrigerator until ready to use; it keeps indefinitely. You can eat this meat as you would beef jerky, or prepare the dishes suggested below. Makes about ¾ pound (or about 3 to 4 cups, lightly measured).

Carne seca moistened in a sauce is a fine choice for tacos or miniature chimichangas; or it makes the base for a rich soup called Casuela (named for a Mexican cooking pot). If you want some carne seca for snacks, make just ½ or ⅓ of this recipe. You can freeze this sauce.

Carne Seca Sauce. Pour ⅔ cup hot water over 3 cups (or 1 recipe's yield) of carne seca and let stand about 20 minutes, stirring occasionally. Pound meat with a little of the liquid in a mortar and pestle (or place between sheets of waxed paper and pound with a flat-surfaced mallet) until it is shredded-looking and in small particles.

Layer *strips of well trimmed top round in a deep bowl with the onion-vinegar-seasoned mixture. Cover and chill overnight*

In a wide frying pan, heat 1½ tablespoons salad oil and add 3 peeled and seeded medium-sized tomatoes; 2 cups (about 4 bunches) chopped green onions, including some of the green tops; and 1 can (4 oz.) green California chiles (first remove seeds and pith, and chop chiles). Reserve some of the chiles to add after the sauce is made, if you want to calibrate the hotness of this dish.

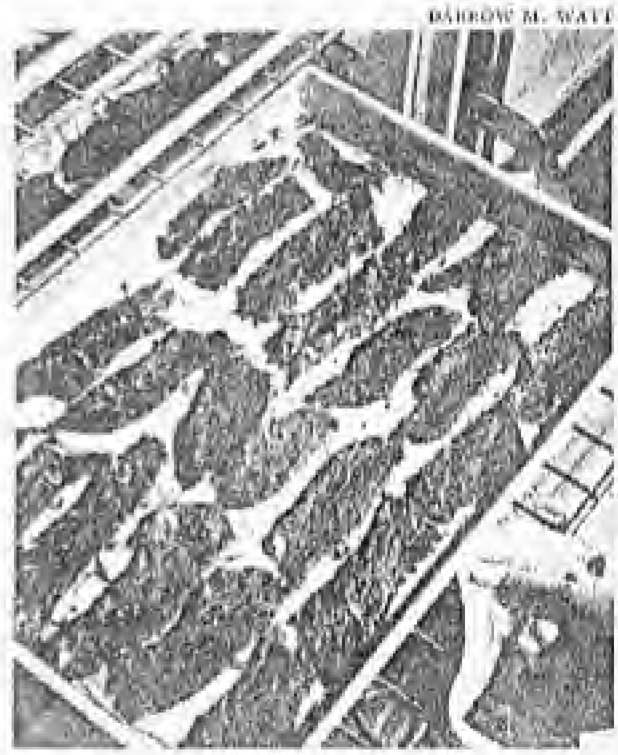
Cook vegetables over medium high heat, stirring, until the onions begin to soften; then add 3 cups beef or chicken broth (canned or freshly made) and the pounded carne seca. Cook, uncovered, over medium heat, stirring occasionally, until the liquid is nearly all absorbed; about 30 minutes.

To serve, spoon into soft, hot unfried corn tortillas (moistened lightly and warmed in a dry pan over high heat, turned frequently); or the miniature chimichangas (directions follow). Makes 5 cups.

Chimichangas, a specialty of Sonora, are enormous tacos made with the platter-sized flour tortillas common in that Mexican state. You can make a smaller version with flour tortillas available in refrigerated sections of many markets. The tortillas become flaky when fried.

Miniature Chimichangas. For each flour tortilla (about 7 inches in diameter) spoon 3 tablespoons carne seca sauce down the center of tortilla. Fold tortilla around filling, and hold shut and seal ends with wooden toothpicks. Assemble only 2 or 3 at a time, as the tortilla will absorb liquid from sauce. Fry in 1 inch of hot salad oil over medium heat (about 350°), turning, until golden; takes 1 to 2 minutes. Lift from fat with a slotted spoon, draining, then place on thick layer of paper towels; keep in a warm place until all are cooked. Serve chimichangas garnished with 2 or 3 tablespoons *each* shredded Cheddar or Longhorn cheese and shredded lettuce, and radishes or green onions. Allow 2 or 3 for a main dish serving.

DARROW M. WATT



Meat *is dry enough to remove from oven when it is completely dry to touch and has firm, leathery texture. Store airtight*

Just add broth and the fragrant herb cilantro (coriander) to the carne seca sauce to make a refreshing, hearty soup.

Casuela. For every 1 cup carne seca sauce, add 1 to 1½ cups chicken broth (canned or freshly made) and ¾ to 1 teaspoon minced fresh cilantro (the Mexican name for fresh coriander, also known as Chinese parsley) or ¼ teaspoon ground dry coriander; bring to boiling.

Allow 1 to 1½ cups for each main dish serving, less as a first course.

YOU CAN BE A Plant Wizard

By Arthur Hawthorne Carhart

POPULAR SCIENCE MONTHLY
JULY, 1937

ANYONE who produces a new plant variety generally gets called a "plant wizard." That term alone is enough to make the average hobbyist shy away from the field of plant breeding. As in many another activity, however, once the hocus-pocus is stripped away, the amateur will find in the creation of new plant varieties an engaging and genuinely adventurous spare-time activity. Furthermore, unlike some hobbies, this one offers a good chance for financial returns.

It must be admitted at the start that plant breeding in its deeper ramifications is an intricate study. At times, it baffles the most expert. But, if you wish, you may be a "plant wizard" in your own back yard. A limited number of flowers in the home garden, common garden instinct, knowledge of basic steps required, and a steady hand are all that are needed to produce new-type seedlings.

The essential part of producing new plant varieties is artificial cross-pollination. Anyone may succeed in doing this. The first step is to decide what species you will work with. Annual plants give quick results. They show the results of crossing in blooms from seed the following year. Sweet peas, marigolds, snapdragons, and cosmos are examples of these annual flowers. Perennials, such as irises, bulbous plants like tulips and gladioluses, require several seasons before blooming. Roses and other woody plants need a longer period. Patience is indispensable in dealing with slower-maturing species. A new variety of apples may not prove itself for seven to ten years, and, of course, fruits require more space than an average home affords.

Amateurs will find irises, gladioluses, sweet peas, and snapdragons easy to work with. Among vegetables, tomatoes, garden peas, and the melon family are easy fields.

Preliminary to crossing, ascertain whether the plant you are planning to hybridize produces "complete" or "incomplete" blossoms. The former carries both male and female elements of the flower in one bloom. The latter produces male elements in one flower, female in another.

From school botany we learn that the male element is the anther or pollen bearer, and the female element is the pistil, attached at its base to the ovary, which develops into the seed pod. Generally, in a "complete flower," the stamens will be found in a location around the pistil, so that wind or insects will jar the tiny grains loose so they drop on the pistil and complete the act of fertilization. So, in order to make sure you really have crossed two varieties, you must remove the stamens of the flower to be pollinated before the pollen becomes ripe and breaks out dustily to impregnate the female element.

A rosebud ready for crossing and, at right, opened to show the stamens and the pistils which receive the pollen

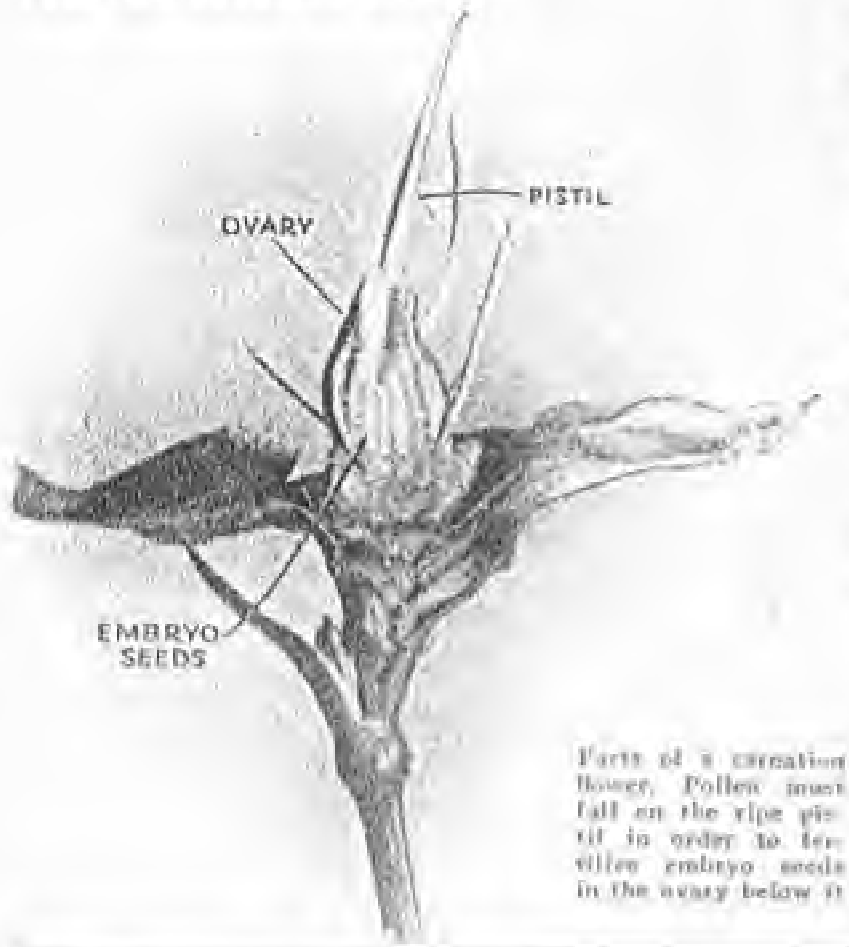
The same rose with petals and stamens removed. The tweezers indicate the pistils, on which pollen from a male parent are placed

After you have selected a female parent for your experiment in hybridizing, break open a flower that is still in bud. With a pair of tweezers, using a magnifying glass if flower parts are small, pluck out the stamens. If your magnifying glass reveals the stamens ripe and dusty, the flower has not been prepared early enough. Take another, less mature.

After the immature stamens have been removed, cover the emasculated flower with a square of waxed paper to prevent insects or other agencies from causing a "wildcat" cross. After several days examine the pistil. If the surface shows gummy under the hand glass, it is ready for pollen.

Select a male parent with ripe pollen, and transfer some grains to the female parent. One accepted way is to dust off ripe pollen into a clean watch glass, pick it up with a small camel's-hair brush, and apply it to the pistil's gummy surface. A more direct way is to lift a ripe stamen from the male parent with tweezers, carry it guardedly to the female parent, and apply the dusty pollen directly. Looking through the magnifying glass, you usually can see the pollen grains adhering to the surface of the pistil, which indicates that your transfer is completed.

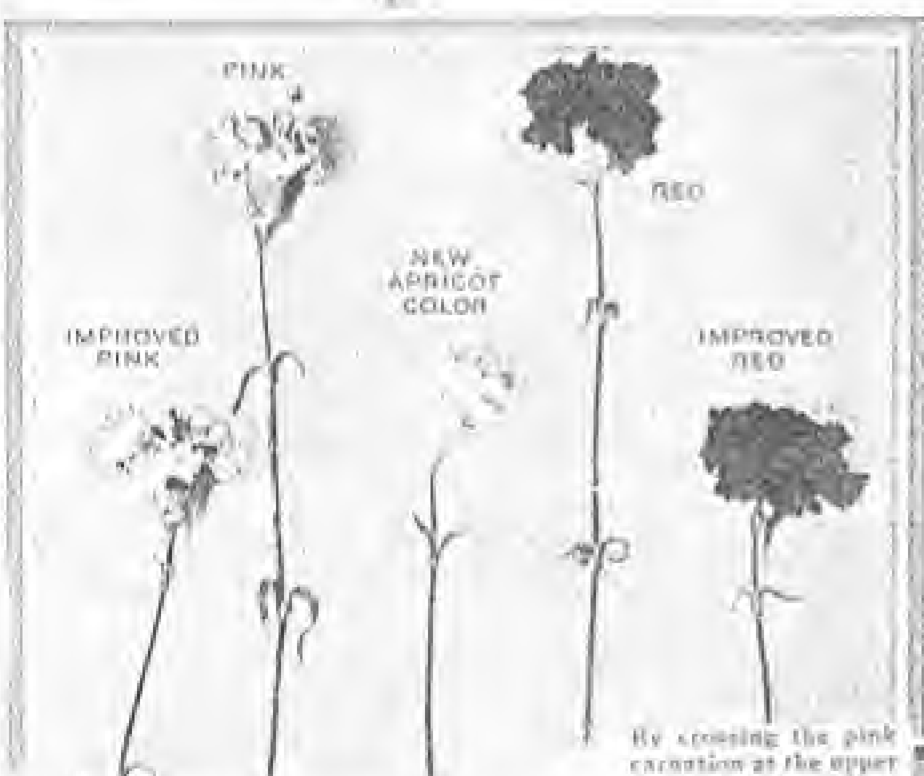
HOW TO CROSS-POLLINATE CARNATIONS . A SIMPLE EXAMPLE OF ARTIFICIAL PLANT BREEDING



Parts of a carnation flower. Pollen must fall on the ripe pistil in order to fertilize embryo seeds in the ovary below it

1 The flower selected for the female parent must be in bud

2 Break the flower open, folding the petals back to expose the stamens and pistil



By crossing the pink carnation at the upper left with the red at the upper right, the author produced seeds from which grew an improved pink (at lower left), an improved red (at lower right), and an entirely new color in carnations, apricot, seen in the center

3 With a pair of tweezers, pluck out the still immature stamens

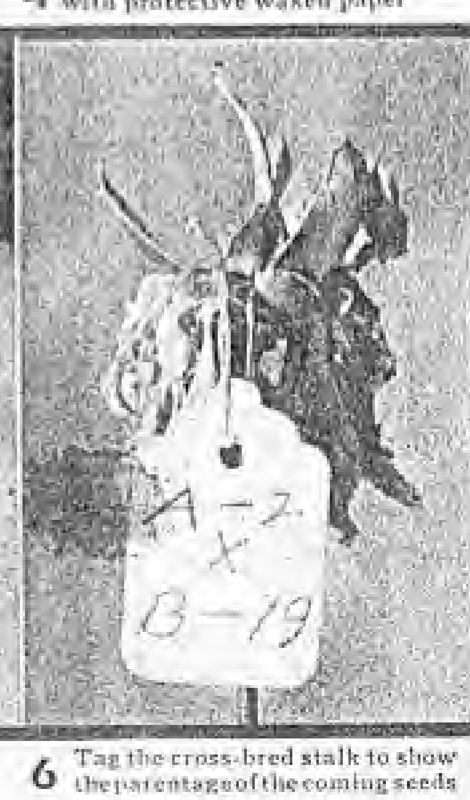
4 Cover the emasculated bloom with protective waxed paper

Re-cover the fertilized female parent flower with waxed paper and mark it with a tag to show the parentage of seed that will be in the pod. The pistil withers and the seed pod swells, showing that seeds have formed and the waxed paper can be removed. When the seed pod is ripe, the whole stock can be removed and stored. At planting time, a small stake label bearing the cross parentage is placed on the row or section in which seeds from each single pod are sown. Then wait for the show of bloom.

At blooming time, give a serial number to each seedling worth saving. Save seedlings for two purposes; for their own quality and for breeding use in subsequent generations. Enter the seedling number in a note book, recording its parentage. It is important to know, in the future, the "blood lines" of each seedling.

FOR example, you are crossing a red and a white flower, hoping to develop a salmon tint. You obtain a white seedling that has

5 When the pistil is ripe, select a stamen from the male parent and apply pollen



6 Tag the cross-bred stalk to show the parentage of the coming seeds

all the qualities you are after except color. But you know the red strain is in it, for your record shows that. Now, you cross this with a yellow variety. For there is reason to hope that the white-red seedling blended with the yellow will combine the lightness of white, the red tinge of the red parent, and the yellow color to produce a salmon. Your records are your guide; keep them always.

All tools and supplies for your new hobby can be purchased for less than two dollars. They include small hand tweezers, a magnifying glass, a small notebook, some waxed paper, a bundle of durable price tags, and a few cents' worth of garden-stake labels. Manicure scissors are helpful in removing the stamens of some flowers.

The intricate part of plant breeding involves the science of genetics, which gives the groundwork on which a breeder may reasonably predict what he will secure from any cross, provided he knows the blood-line parentage. Genetics is a study in itself, but a practical basis for determining how to cross to get results can be briefly presented.

Each parent has characteristics that are carried to the hybrids. Half a century ago, an Austrian monk named Mendel worked out the law of ratios in which these characteristics will appear in hybrids. His experiments were made with sweet peas. Examination of a sweet pea discloses that both male and female elements are enclosed in a pouch in the lower portion of the flower. Neither insect nor wind can naturally cross-pollinate a pea blossom. They are self-pollinating after an initial hybridization. By "selfing," or inbreeding the blooms beyond the first generation, Mendel learned the way in which the unit characters of parentage will continue to split. Thus came to us "Mendel's law," which is the foundation of scientific breeding.

SIMPLY stated, Mendel's law teaches that, with reference to a given characteristic, one fourth of the hybrids will resemble one parent, one fourth the other parent, and half will be "indeterminate." Seed from this indeterminate group break again in the same ratio when only one unit character, like color, is considered.

In practice, a cross between a white flower and a red one may show one fourth red, three fourths white. This is because the white is conferring what is known as a "dominant" characteristic. It overshadows the other color character, which is "recessive."

Therefore, the plant breeder recognizes that if a white-red cross is made, and one fourth of the hybrids show red, while three fourths show white, he has the red color "fixed" immediately. But because two thirds of the whites are "indeterminate" hybrids, he must work farther to "fix" that color so it will come true from seed. The "fixing" is merely carrying the dominant color through enough generations to determine which are the "fixed" hybrids of that dominant color.

THIS law applies only when dealing with one unit character, such as color. Practically, the parentage of any flower the amateur deals with is thoroughly mixed already, and the results will show all sorts of intermediate coloring blends, all sorts of other combinations of any single unit character. Furthermore, it is important only when dealing with plants that must be propagated by seeds. It need not worry the hybridizer who works with plants that can be propagated by cuttings, slips, scions, or bud grafts, for such propagation carries characteristics indefinitely.

Do not overlook the fact that every seedling carries the characteristics of both parents. Some may be submerged, but they are there. By crossing, you may recover them. One plant may have vigor, size, everything but the blossom sought. Another may have the blossom you want. Recross them, and somewhere in the resulting seedlings you will get the combination you want. Look on your crossing as a blending process, from which you select those individuals that show promise of producing what you seek. Approaching from this angle, anyone can make crosses intelligently.

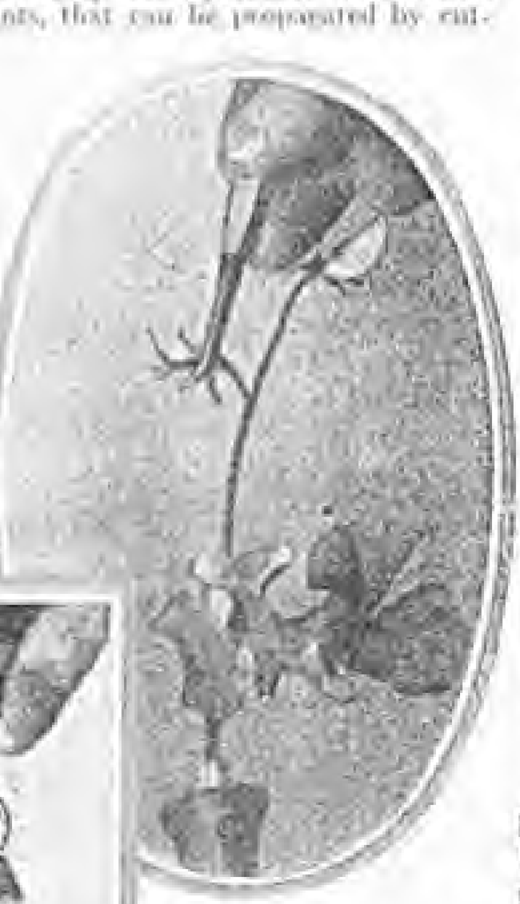
Pollen generally is fertile only on plants of closely related species. A climbing rose can be crossed with a wild rose, or a tea rose with a climber. Natural limits allow a pumpkin to cross with a squash, or either might cross with a cucumber. A tomato has been crossed with a pepper; they belong to the same order of plants.

In this field of crossing between different species in the same family, lies what has been called "plant wizardry." Not even the best plant breeders know how far this sort of cross may be "crowded." It is a shot in the dark. Amateurs will get more certain results by working within a species. But if these "freak" crosses are attempted and are successful, a wholly new sort of plant may result.

Plants that must be propagated from seeds are likely to "break" every which way, and the "fixing" of a new seed-propagated variety may become tedious. A freak cross may be more easily fixed in its characteristics than a cross within varieties. If the amateur plant breeder wishes to get permanent results in the first few generations, he should deal with plants that are propagated asexually—that is, by slips, root stocks, bulbs, or grafts. If you cross irises, and the first generation shows an exceptional seedling, production by division of the root stock will carry to the new plants, all of the characters of that seedling. Gladiolus will do the same in that species. Roses, or similar wooded plants, are similarly propagated by buds, cuttings, or grafts.

THE art of cross-pollination can be accomplished by anybody. Common judgment and alertness in the interpretation of results will go far in bringing success in the production of new varieties. The tools are simple. The laboratory and test plot may be a few square feet in the home yard. One might even produce a new geranium variety in a window box.

Plant breeding can be a fascinating spare-time activity, costing little, perhaps bringing a surprising financial return, if a superior variety or promising novelty is produced. Try it—in your own back yard.



Tweezers removing stamens from a sweet-pea bloom. The upper bloom still has its covering

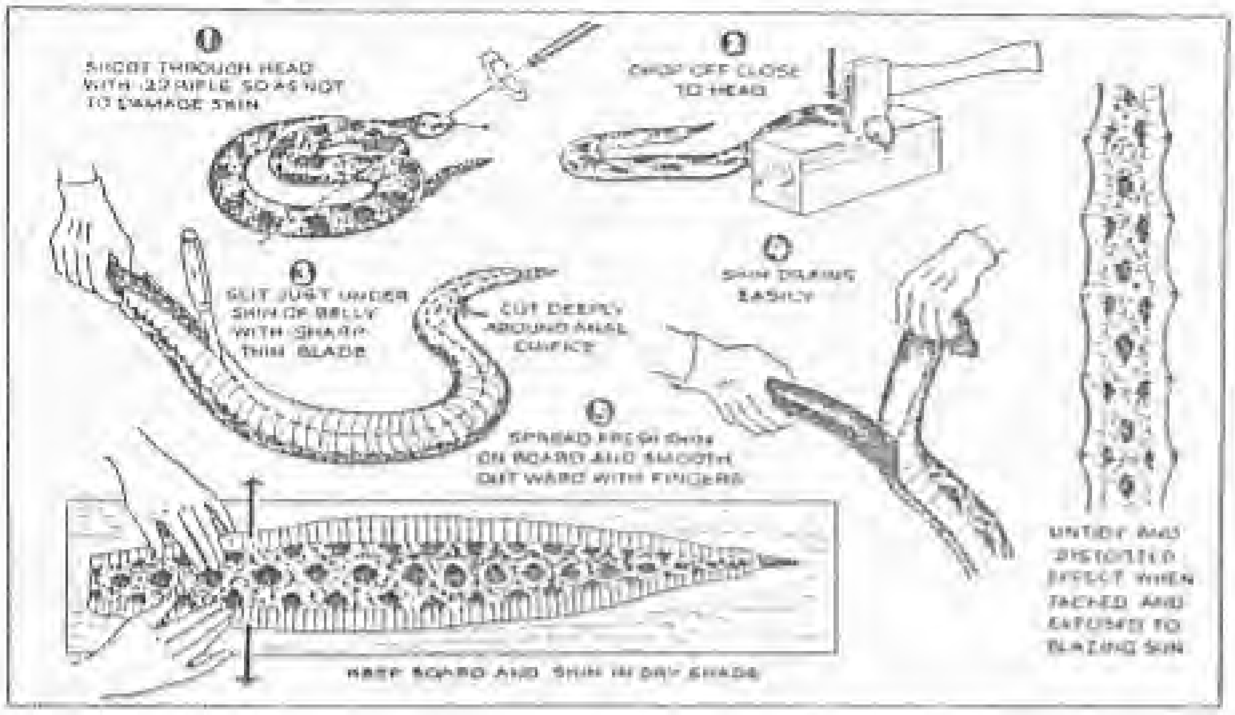
At far left is a marigold with part of its stamens plucked. Left, the flower being pollinated with the stamens of another parent

Raising the Temperature of a Room

Popular Mechanics — 1919

The temperature of a room may apparently be raised several degrees with the same expenditure of heat, and greater comfort will result by the application of a simple principle. In summer a moist day seems warmer than a dry one though the thermometer registers the same. By permitting steam to escape from a radiator or keeping a kettle boiling on the stove, the air is moistened and feels warmer.

How to Mount a Snakeskin



SNAKESKINS, particularly those of diamond-back rattlers, make handsome decorations if properly mounted. But when merely tacked up to dry in a blazing sun—the usual method of novices—they are anything but attractive, soon becoming distorted, wrinkled, and colorless.

If possible, the snake should be killed with an eye to an undamaged skin, and the best way to accomplish this is to shoot it through the head, just back of the eyes. One can safely approach a coiled rattlesnake with a .22 caliber rifle, because invariably it will strike at the gun muzzle; and its striking range is only a few feet, allowing you to get close enough for accurate aim. However, if you do not kill a rattler outright, be sure to note whether it bites itself. They often do that when wounded, and then you must handle the body with caution. Old-timers in the rattlesnake country of the Southwest say that one may become poisoned just by handling a bitten snake's body. Also, take care not to touch the mangled head, as the poison sack may be ripped, or a splinter of fang may puncture a finger. Safest method is to use an old pair of leather gloves to protect your hand.

The snake will squirm for some time after you kill it, but should be skinned before it stiffens. First step is to chop off the head close to the base of the skull; then, with a sharp, thin-bladed knife, slit down the middle of the underside with a cut just deep enough to sever the armorlike bottom scales. Most difficult part to cut is the tail end, and great care must be taken at the anal orifice, where the skin clings more tightly to the flesh than at the forward section. Cut deeply around the orifice and slit from there to the rattles. This final section is tough and hard to skin, but since the skin here is striped instead of diamond-patterned, it should, if possible, be left connected to the rest of the skin. Otherwise it will appear to be part of a different kind of reptile.

As soon as it is freed from the flesh, spread the skin, flesh side down, over a pine board, working outward with the fingers to stretch it. A viscous substance, very much like glue, adheres to the flesh side of the skin and will permanently cement it to the board. The board, for a time, should be kept out of the hot sun, but placed in dry shade. When the skin is completely set in a few days, a coat of shellac may be applied to the scales to preserve them against the ravages of dampness.—*H. Sibley.*

Noodle Puffs

For noodle puffs, make your noodle dough, roll out and let lie until moderately dry. Cut in half and put one half over the other. With a floured thimble cut out puffs. Press the thimble firmly enough so the edges stick together. Fry them in deep oil until brownish and serve as soup crackers.

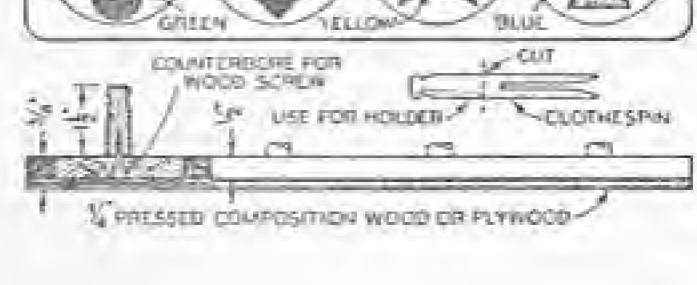
Block-Fitting Toy

TEACHES SHAPES AND COLORS

The blocks are jig-sawed to the shapes shown at the right. Each is given a distinguishing color and placed in a painted circle of the same color

MANY hours of constructive play are in store for any child of from one to two years old who is given a toy like that illustrated. In fitting the various colored blocks into their holes, he will learn discrimination in size, color, and position. The cost is negligible.

The main portion of the toy was jigsawed from the end of an orange crate to fit the tray of the child's chair. After the square, triangle, and other figures had been carefully sawed out, a piece of pressed composition board was tacked to the bottom to prevent the blocks from falling through. The upper part of a clothespin was then screwed to each block as shown to serve as a handle.



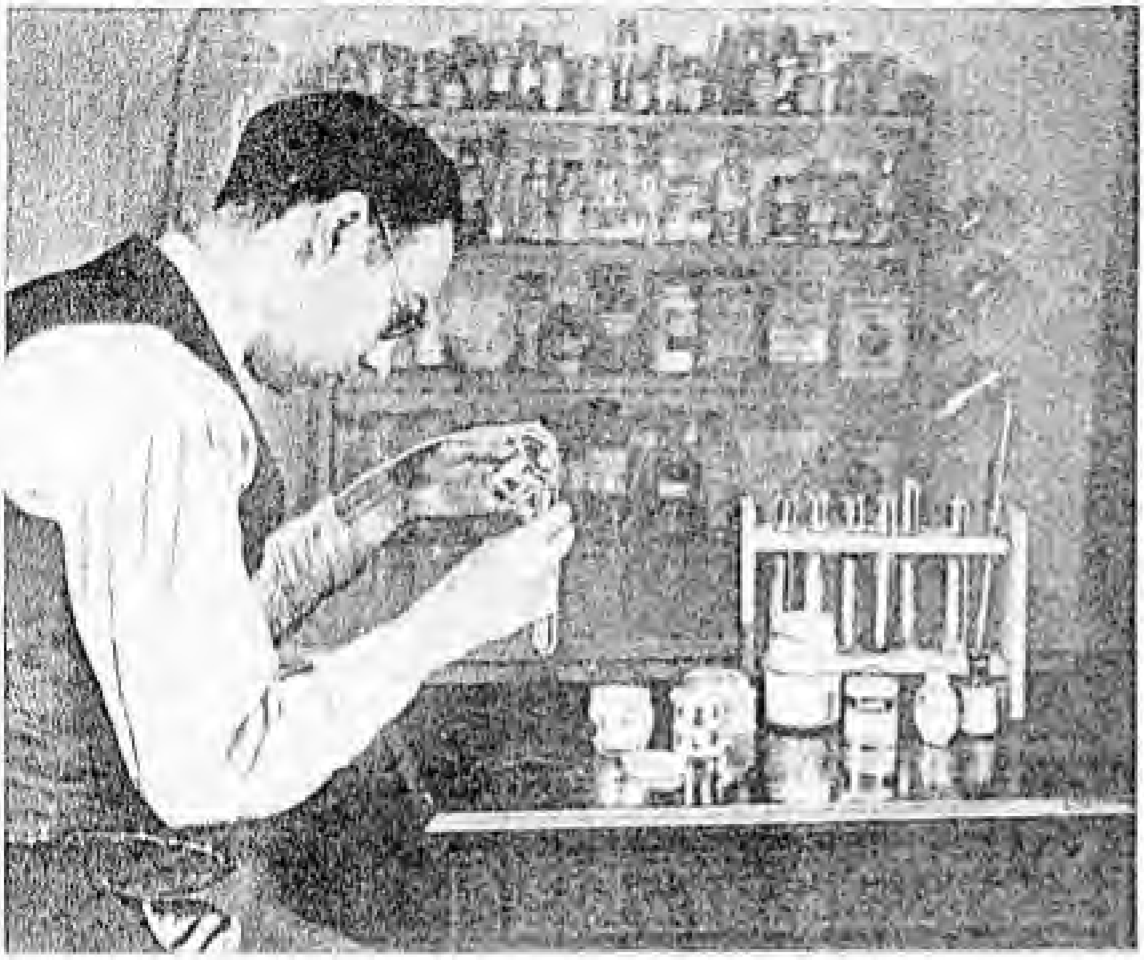
The whole set was given a ground coat of white enamel; when this was dry, each block, the inclosing circle, which is merely painted on, and the hole were given its own particular distinguishing color. The handles were all left white for the sake of contrast. Of course, nonpoisonous finishes should always be used.—M. E. NIXON.

What's It Made Of?

By
RAYMOND B. WAILES

HOW TO ANALYZE HOUSEHOLD PRODUCTS IN YOUR OWN LABORATORY

POPULAR SCIENCE MONTHLY JULY, 1937



The amateur testing laboratory in operation. At the right, a wad of cotton wet with hydrochloric acid is being held above some tobacco and lye water in a beaker to prove that nicotine is present

TESTING household products offers a fascinating and practical diversion for an amateur chemist. Simple experiments, well within the natural limitations of a home laboratory, will yield a surprising amount of information about such preparations as ammonia, medicines, tooth powder, cosmetics, tobacco, and a variety of others.

When you purchase a bottle of household ammonia, you actually are getting a solution of ammonia gas in water. In case two brands are similarly priced, the one containing the most ammonia is, presumably, the best buy. You can easily find out for yourself which is the stronger by "titrating" them with dilute sulphuric acid.

Place exactly equal amounts of the two brands of ammonia in separate test tubes—about ten cubic centimeters, or three teaspoonfuls, will do—and add to each test tube a drop or two of methyl orange indicator. Then add weak sulphuric acid, drop by drop, to one of the test tubes until the color of the solution changes from orange to red. Note the quantity of acid used. Repeat the test with the contents of the other tube. The ammonia that requires the most acid to effect the change is the stronger. If you add the acid from a graduated tube or burette, the exact amounts used may easily be compared. Acid of suitable strength for this test can be made by diluting three cubic centimeters of strong sulphuric acid with water, to a total volume of 100 cubic centimeters (a drinking glass contains about 240 cubic centimeters).

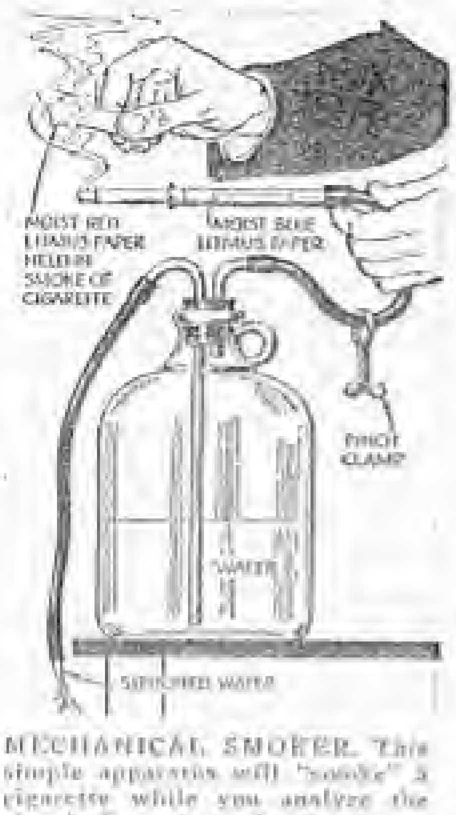
Drug-store remedies for indigestion usually consist of baking soda (sodium bicarbonate) combined with various other materials. Many of
the brands contain

Handy Kit for Chemical Reagents

TO HOLD the small quantities of reagents used in "analytical" tests like these, you can make a neat and professional-looking little kit. Obtain a number of small bottles of uniform size, and fit them with medicine droppers, passed through holes in the stoppers. If the mouth of each bottle is small, you can simply slide a half-inch length of rubber tubing over the medicine dropper and use the dropper itself as the cork. A small wooden box of convenient dimensions keeps the bottles in order. Your kit may include "indicators" and other solutions that you frequently use about the laboratory, such as methyl orange, phenolphthalein, sulphuric acid, sodium hydroxide, and silver nitrate. As silver nitrate is decomposed by light, keep this chemical in a brown-glass bottle, or in an ordinary bottle painted with black varnish.

Indicator solutions for analyzing household products are kept conveniently in small bottles with medicine droppers

some form of bismuth, and the presence of this comparatively high-priced ingredient can be detected by a simple but interesting test.



MECHANICAL SMOKER. This simple apparatus will "smoke" a cigarette while you analyze the chemical products in the fumes

If the product is a powder, try heating some of it in a test tube with a mixture of powdered potassium iodide crystals and flowers of sulphur. If it contains bismuth, the resulting chemical reaction will release the vapor of bismuth iodide, which will condense as a scarlet solid on the inside wall of the test tube. This "sublimate" can best be identified with the aid of a magnifying glass, after the tube has cooled and the brown drops of distilled sulphur have turned yellow, as otherwise the sulphur may be mistaken for the scarlet bismuth iodide. To test a liquid preparation for bismuth, heat it in an evaporating dish until nothing but solid material remains, and proceed as before.

Many tooth powders contain sodium perborate, which releases oxygen gas when it is moistened. One way to detect it is to test the tooth powder for boron, an element present in the perborate compound, which has the characteristic of turning a flame green.

Place some of the tooth powder in a test tube that has a side arm as shown in one of the photographs. Add enough strong sulphuric acid to cover the powder, and then an equal amount of grain or rubbing alcohol. Connect the side arm of the test tube, instead of the regular gas supply, to the gas inlet of a Bunsen burner and heat the contents of the test tube. You will find that you can light the gas issuing at the top of the burner, and the resulting flame will be colored green through the formation of a compound known as ethyl borate ester, if the tooth powder contains sodium perborate.

Oxygen released by a tooth powder of this type comes from the decomposition of the hydrogen peroxide that is formed through the interaction of sodium perborate and water. This provides another test for the tooth powder. If hydrogen peroxide is formed when it is moistened, it must contain the perborate compound.

You can test for hydrogen peroxide with an easily prepared solution made by dissolving five grams (about a teaspoonful) of ammonium molybdate crystals in fifty cubic centimeters of water and then adding fifty cubic centimeters of strong sulphuric acid. Several drops of this reagent, added to a solution obtained by stirring some of the tooth powder in a little water, will show up any hydrogen peroxide by turning the liquid yellow. You can make sure your reagent is working properly by trying it out in another test tube containing several drops of drugstore peroxide.

A variation of the preparation just described also can be used to test for the peroxide. Add a teaspoonful of a ten-percent ammonium molybdate solution to the liquid under test, followed by several drops of a dilute solution of citric acid. Again, a yellow color develops if hydrogen peroxide is present.


Cigarette paper being reduced to ash to disclose the filler with which it may be "loaded." The crucible is supported on a nichrome-wire triangle

Add a few drops of salt water to a solution of silver nitrate, and you will observe a precipitate of silver chloride. The white precipitate will turn gray and then black when exposed to the light. Similarly, if you add several drops of a solution of sodium chloride, or table salt, to the liquid contained in the brown glass bottle furnished with many hair-dye "sets" or colors, a white precipitate will form. It turns grayish-black when exposed to the light, indicating that the amber bottle contains a soluble silver salt. In most hair dyes, this salt is silver nitrate.

A powder accompanies the hair dye. The instructions direct the buyer to dissolve this in water and apply it to the hair following the use of the silver nitrate solution. Try adding an acid, such as sulphuric acid, to the powder, and acrid sulphur dioxide gas will be liberated. If you treat a solution of the powder with several cubic centimeters of silver nitrate solution, you will obtain a brown precipitate that slowly turns dark. This silver precipitate is the agent that colors or dyes the hair. Reactions like those you have just observed indicate that the powder is a thiosulphate.


This test reveals the presence of sodium perborate in a tooth powder, which is heated in the test tube with sulphuric acid and alcohol

Some freckle-removing creams contain ammoniated mercury, which may prove harmful to the skin. A simple way to test for mercury in such a cream is to heat several grams of it with a dilute solution of lye or other caustic, stirring meanwhile with a glass rod. Then immerse a strip or sheet of metallic aluminum, such as the metal-foil wrapping from a candy bar, in the liquid. The caustic reacts with the aluminum, giving off hydrogen gas. At the same time, any mercury in

the solution will amalgamate with the aluminum. Remove the aluminum foil, wash it thoroughly with water, and set it aside without attempting to dry it. If mercury is present, the foil soon will emit crackling noises, and a fluffy white growth of alumina will appear upon its surface.

A modification of this test may be performed by heating together for a quarter of an hour a one-gram sample of the freckle cream, a strip of aluminum foil, a third of a teaspoonful each of five-percent sodium hydroxide solution and twenty-five-percent sodium thiosulphate solution. In this case, mercury is present if the growth of white alumina appears after the metal foil has been washed with alcohol or acetone.

Tobacco smoke, blown through a handkerchief, produces a brown stain—not of nicotine, as many suppose, but of vegetable tar distilled from the burning shreds. Extracting and testing for the nicotine itself is one of a number of interesting experiments you can perform with cigarettes, cigars,

and cigarette paper in your own laboratory.

Pure nicotine is a colorless liquid. What a chemist means when he speaks of the "nicotine" in tobacco, however, is nicotine citrate or nicotine malate. These are nicotine salts of citric and malic acids, the acids familiar to us in lemon juice and in apple juice.

Calling a salt like nicotine citrate by the plain name of "nicotine" should not confuse you. When we speak of the potassium that plants need in the soil for their proper growth, for example, of course we mean some salt of the metal, such as potassium carbonate or potassium silicate, and not the metal itself. If the ground actually did contain metallic potassium, which reacts with water to produce fire, what a picturesque and terrifying place the earth would be each time it rained!

TO TEST for the nicotine in tobacco, break up several cigarettes or half a cigar in a tall jar, beaker, or glass vase, and add several fluid ounces of a solution of sodium hydroxide (lye water) to the tobacco. Now hold a blob of absorbent cotton, wet with strong hydrochloric acid, just above the contents of the vessel. You will see a dense white cloud of "smoke" form around the cotton.

The chemistry of the process is simple. The alkali or lye water releases the nicotine from its combination with citric or malic acid and forms free nicotine. As this liquid is highly volatile, some of it is liberated in the vessel as a vapor. Now, when the vapor of hydrochloric acid is introduced in the vessel by the acid-soaked cotton, the nicotine vapor reacts with it to form nicotine hydrochloride. This is the white "smoke" that is formed. You may recall that the vapors of hydrochloric acid and of ammonia also react to form white smoke, consisting of ammonium chloride, but you can readily show that ammonia is not involved in the present instance. A wet strip of red litmus paper, held in the vessel after the caustic is added, does not turn blue, showing that no ammonia vapor is released by the action of the alkali.

Large tobacco companies employ ingenious machines to smoke cigarettes mechanically and analyze the chemical products in the smoke. If you wish to investigate for yourself what happens when tobacco burns, you can easily rig up one of these "robot smokers" in simplified form.

Fit the tip of a cigarette into one end of a glass tube, which serves as a holder. Connect the other end of the tube to a glass L tube, using rubber tubing provided with a pinch clamp or a spring-type clothespin. Insert the L tube in one hole of a two-hole stopper fitted to a gallon jug of water, which acts as a suction pump. The other hole in the stopper carries a longer glass tube that dips into the water, and at the top of this tube a long section of rubber tubing is attached. The siphon is started by sucking on this rubber tubing. When you open and close the pinch clamp or spring clothespin, the cigarette in the holder can be smoked in puffs, realistically imitating the customary manner of smoking.

PLACE a wet strip of blue litmus paper in the glass tube that serves as the cigarette holder, and set the robot smoker working—or, if you are a user of tobacco, simply place the glass tube to your lips, without the attachments, and draw the smoke through it. Presently the litmus paper will turn red. The change is produced by formic acid and other acids contained in the smoke.

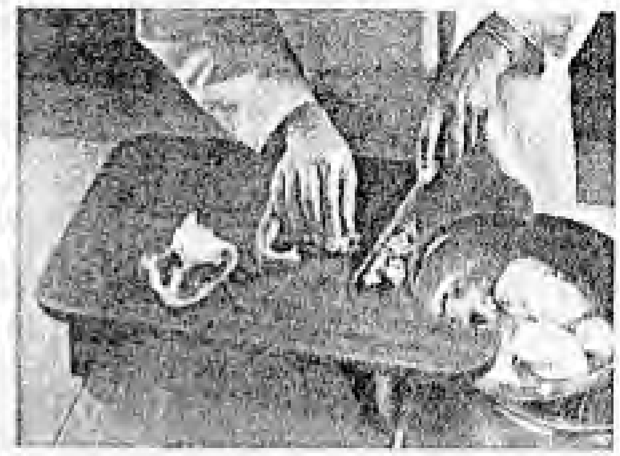
Quite different, however, is the smoke coming from the other end of the cigarette—the wisp that curls upward from the glowing tip, and that is not

drawn into the mouth in smoking. Hold a wet strip of red litmus paper in this smoke, and the test paper will turn blue, showing the presence of an alkali—in this case, ammonia. If your eyes have ever smarted in a room that is cloudy with tobacco smoke, now you know why; the ammonia vapor released by the burning tobacco is largely responsible.

A bit of chemical testing also will give you an insight into the chemistry of cigarette paper. Often this material is "loaded," or impregnated with some filler, to make it more opaque and to control the rate of burning. This should in no sense be considered an adulterant, since it is not used to cheapen the product, but is incorporated with the paper pulp to serve a useful purpose. Calcium carbonate, the same material of which chalk and marble are composed, is the filler generally employed.

TO TEST for this material, reduce several sheets of cigarette paper to ash. The best way to do this is to heat the paper in a porcelain crucible or evaporating dish, using a Bunsen burner, until the carbon has been entirely burned out. This will leave a white ash behind. During the heating, the calcium carbonate will have been converted into calcium oxide, or quicklime. Add several drops of water to the ash, and calcium hydroxide, or slaked lime, will form and dissolve. Now, when you add a drop or two of phenolphthalein to the liquid, it will turn violet-red, showing the presence of an alkali. The alkali responsible for the appearance of this color comes from the calcium carbonate originally present in the cigarette paper.

Instead of adding phenolphthalein, you can dip a platinum wire in the solution you have prepared, and then hold the wire in the blue Bunsen flame. The presence of calcium tinges the flame with a carmine-red color. A little of the liquid may also be filtered and treated with a solution of ammonium oxalate. A white precipitate forms. When ammonium oxalate solution is added to a liquid under test, such a precipitate strongly indicates that the liquid contains calcium.

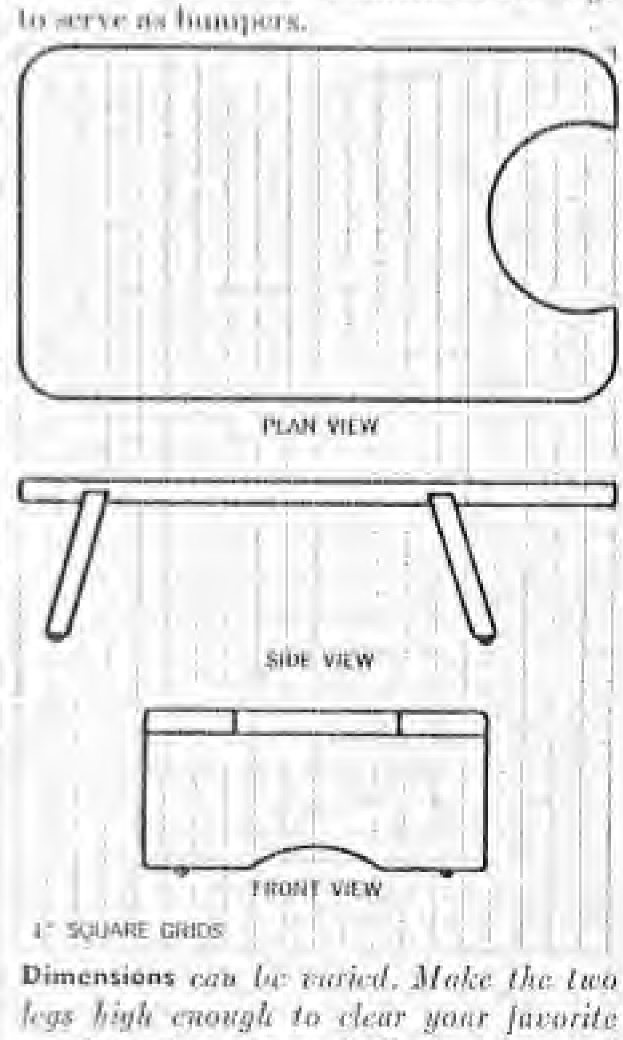


Raised *cutting board makes it easy to add vegetables at different times to hot pan*

We raised our cutting board

We have used this cutting board for several months in our new test kitchens and find it very handy. You slide a bowl underneath it or place it over a hot pan, as shown above. Then just cut or dice your food and push it in.

Ours is made of walnut but the board could just as well be made of inexpensive pine. Cut and attach the legs at a 20° angle, using a waterproof glue, no nails or screws. If you do not have a power saw to cut the two slots, attach the legs with deep-set screws through the top. Finish the board with a coating of salad oil, applied with a rag. Attach four small rubber-headed tacks to the bottoms of the legs to serve as bumpers.



Dimensions *can be varied. Make the two legs high enough to clear your favorite salad bowl, and round all the edges well*

Waterproof Fire Starters

OUTDOOR LIFE
September, 1943

YOU know how it is to try to start a camp fire by striking a wet match on a wet rock. Just to make it hard, the kindling is usually wet too, and so are you—not to mention being dead tired, or half-frozen, or ready to drop from hunger.

All that misery can be avoided if you take along a supply of waterproof fire starters. They can be made up beforehand at home, with matches, sandpaper, and scrap insulation board. The pictures show how it's done.

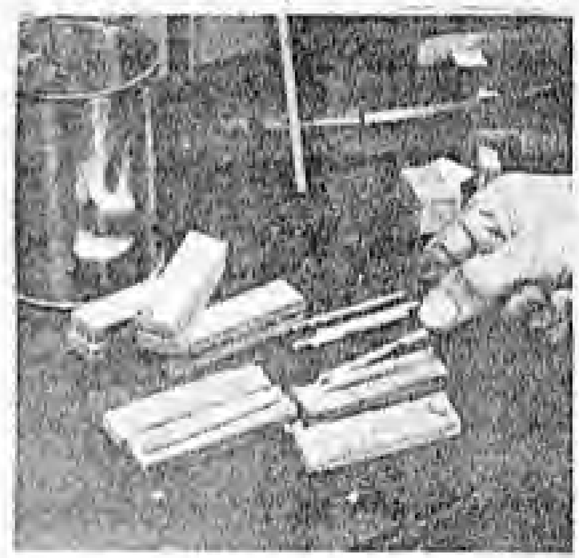
Beauty of it is, you need only a few of the "sandwiches" described—the rest of your quick-starting equipment consists of little squares of paraffin-dipped insulation board. These squares also come in handy even in dry weather, for they'll ignite fairly large twigs and you won't need to gather a lot of small stuff.

Both squares and sandwiches, of course, should be kept in a waterproof container. When carried in your pocket in warm weather, each block should be wrapped in paper to keep it from sticking to its neighbors.

Obtain some scrap insulation board about ½ in. thick—any kind that's porous, soft, easily cut with a sharp knife—and cut into ¾ by 2¼-in. strips. [Also cut some ¾-in. squares, which can be speared with an ice pick, dipped "as are" into paraffin, and used to help start fires. Squares need no further processing]

Split the larger blocks in two, sandwich style, and dig up some kitchen matches

Third, groove both halves of each block so they will fit snugly when a match is sandwiched between them. [Make your blocks ¾ in. wide, and you'll have room for two matches, side by side and headed each way]



Dip the head of each match in melted paraffin, then lay it in its groove. [Safety matches may be used, if you carry a striking surface in a water-tight container]

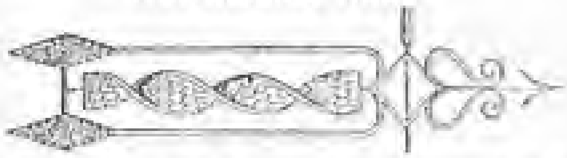
For strike-anywhere matches, lay a narrow strip of coarse sandpaper beside the match. Use No. 2 or 3 sandpaper—finer grits might clog with wax

Sandwich both halves; clamp, or bind with thread; dip into melted paraffin. If wax has visible vapor it's too hot. Soak block till bubbling almost stops, then lay aside (still clamped) to harden

When fuel and ordinary matches are wet, open up one or more sandwiches, feather the ends to make them ignite more quickly, strike the match on the sandpaper, and use the halves for kindling

Scientific American
March 31, 1860

A SPARKLING VANE.



A very curious and elegant vane for spires may be made, by placing in the center, a spiral or twisted spindle, as shown in the above cut. This spindle should be hung on delicate pivots, and the spaces between the spiral flanches nearly covered with small pieces of looking-glass or thin plates of mica. The least breeze will put it in motion, and as the reflectors will assume every possible position, several of them will be sure to present the reflection of the sun at every revolution, from whatever point it may be viewed, thus producing a constant and very brilliant sparkling.

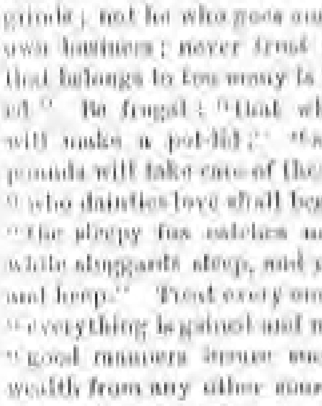
Scientific American
March 30, 1861

HOW TO PROSPER IN BUSINESS.—In the first place, make up your mind to accomplish whatever you undertake; decide upon some particular employment, and persevere in it. All difficulties are overcome by diligence and assiduity. Be not afraid to work with your hands, and diligently too. "A cat in gloves catches no mice." He who remains in the mill grinds; not he who goes and comes. Attend to your own business; never trust to any one else: "a pot that belongs to too many is ill stirred and worse boiled." Be frugal: "That which will not make a pot will make a pot-lid;" "save the pence, and the pounds will take care of themselves." Be abstemious: "who dainties love shall beggars prove." Rise early: "the sleepy fox catches no poultry;" "plow deep while sluggards sleep, and you will have corn to sell and keep." Treat every one with respect and civility: "everything is gained and nothing lost by courtesy;" "good manners insure success." Never anticipate wealth from any other source than labor—especially never place dependence upon becoming the possessor of an inheritance; "he who waits for dead men's shoes may have to go a long time barefoot;" "he who runs after a shadow hath a wearisome race."

Popular Mechanics 1919

Changing a Motor-Car Tire without a Jack.

It occasionally happens that a motorist fails to have a jack at hand when a tire needs to be changed on the road. The situation is easily met with the aid of a strong board and a couple of blocks or rocks. Driving the desired wheel onto the incline, provided in the manner illustrated, and setting the brakes, a block is placed beneath the axle. The board is then knocked out of the way.

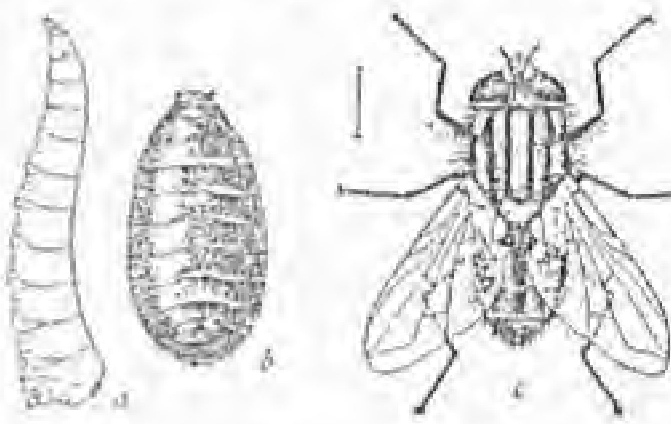


THE FANTASTIC FLY!

by Kurt Saxon

You've probably never given it a thought but the common house-fly is a potential asset to anyone with chickens to feed. The following ideas will enable you to cut your feed bills to zero and even give you feed to sell. (See also Vol. 1, pages 12, 39 and 110).

The common house-fly and the larger blue and green thoraxed flies are wildly prolific. Estimates have been made that if one pair of flies should be allowed to breed with no deaths, in one year they would weigh as much as the Earth itself.



The house-fly. (Enlarged)

a, larva, or maggot; *b*, puparium; *c*, adult. (After Howard, United States Department of Agriculture)

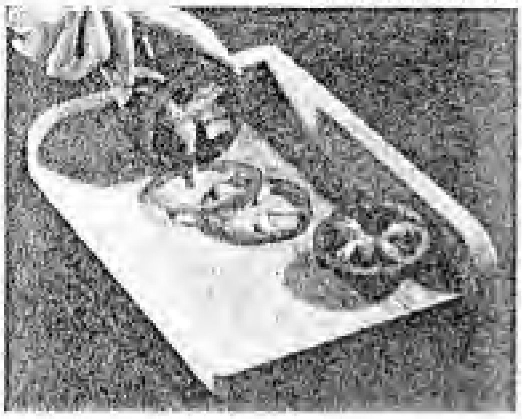
Consider, one fly weighs about a grain with 1500 grains to the ounce. A female will lay about 120 eggs. I don't know the ratio of females to males but let's say half, or 60 females. The cycle from egg to egg-laying female is 10 days to two weeks.

Say you captured a male and female hung together in the act of mating. Put them in a cloth-covered box with a moist slice of baloney and keep it in a warm place. In a few hours the female will lay her 120 eggs. Soon thereafter the eggs will hatch into maggots. After eating the constantly moistened baloney for a few days the maggots will pupate and soon again, adult flies will emerge from the pupa cases and commence to mate and eat, eat and mate, and just lay oodles more eggs. (No need to capture a pair of flies in the act of mating. Just get three or four flies and one or more of them will certainly be females)

If you should expand your operation, in four weeks you would have 3600 females. Two more weeks and you would have 216,000. Another two weeks, 12,960,000. We're just counting probable females, remember? In 12 weeks, or three months, would you believe 47,256,000,000?!

That approximates 31,504,000 ounces, or 1,969,000 pounds, or 984 tons! You would run out of baloney in no time.

We have already slated the waste from the chickens, rabbits and other livestock for earth-



Chopping board

This unusual chopping board would be especially welcome in the kitchen of a cook who often prepares Oriental or other dishes with many chopped vegetables; it was this kind of cooking that originally inspired the board. The two sides brace what you're chopping, control juices, and facilitate carrying chopped pieces from work surface to stove without losing any.

The board shown is made of ¾-inch-thick solid hardboard. Attach the sides with white glue and small nails sunk below the surface, filling the holes with plastic wood. As a conditioner, rub salad oil over all surfaces, let stand, then rub off the excess.—*R. J., Santa Barbara, Calif.*

SUNSET

Popular Mechanics 1919

Improvised Post-Card Projector and Enlarging Camera

By HARRY MARCELLE

AN outfit which may be used for either projecting picture post cards or enlarging photographic negatives was assembled as delineated in the illustration. An ordinary camera, which provides the lens and bellows, is required, in combination with a dark box which can be built in the home workshop. The method of construction is this:

Make a box about 8 in. square out of ½-in. planed soft-wood stock. Nail the sides, but omit, for the present, the top and the bottom. The two openings thus left will be called the front and the back. Mount an 8 by 8 by ½-in. board, D, which constitutes a door, on the back with hinges and provide a hook to hold it shut. Cut a square hole, of the same size as that of the opening in the back of the camera which is to be used, in

worms. But the human waste would be for flies.

Most state laws say that human waste is always waste and cannot be used for growing food directly. This is wise as cities and towns put so many chemicals down their sewers that any end product would be carcinegeous.

Even so, esthetics dictate against using it to directly fertilize plants. The Chinese have used "night soil" directly on plants for thousands of years. Some fields have up to six feet of topsoil. All night soil is avidly collected. Rurals even put up attractive outhouses along roads to entice passersby. So intent are the Chinese on utilizing night soil that a constipated Chinese is flogged and given high colonics.

The human waste for fly food would first go through a grinder. This is because maggots can't eat what they can't get into their little mouths. After grinding the waste would go into a special digester which would generate methane, used as fuel. The methane process would generate enough heat to kill all bacteria and further break down the waste.

What would be left would be a vat of slurry covered by about two thirds of its volume of mineral-rich water. The water would be siphoned off into algae troughs and the slurry would be fed to the flies.

The mineral-rich soup siphoned off the slurry would supply all the minerals the algae needed to divide twice each day.

I suggest three foot wide, 20 feet long, one foot deep wooden, plastic-lined troughs filled with the water. The light from the sun or fluorescent lights, plus a possible heat source under the plastic should supply all the algae wanted.

The harvested algae could be mixed with the dead flies, dried and pelletized or broken up. As chicken feed it would supply all the protiens, vitamins and minerals required, even by chicks.

A fly-feeding unit I've designed would provide 120 one square yard by four inches deep plastic trays. They would be on racks, preferably of sheet-metal and would be 12 high with four inches of space between.

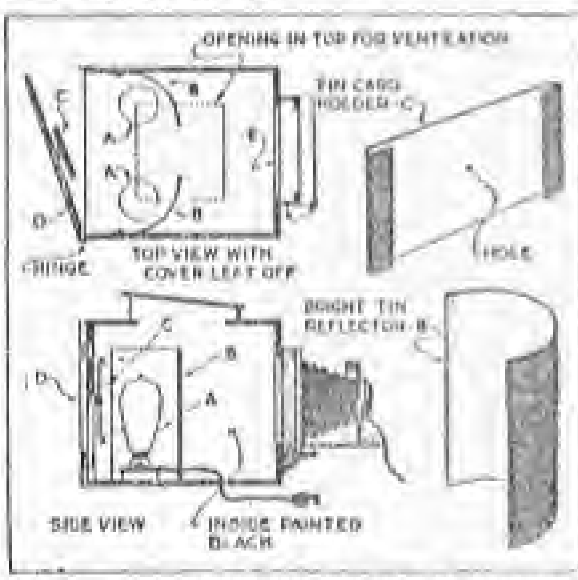
The fly room would be 15 by 10 feet and would hold 10 racks. It would be fully enclosed by window screen to keep the flies inside. In the bottom part of each tray would be a hole with a patch of rubber with a slit in it through which a nozzle would be inserted. The same kind of slit rubber patch would be over holes in the screen adjacent to each tray.

As the maggots ate themselves to pupahood they would rise to the top to pupate. It wouldn't do to put the new slurry on top of the pupas, thus killing them, so the slurry would have to well up from beneath. Two inches from the bottom of each tray would be fixed one square yard of rigid plastic with holes spaced every square inch.

Thus, as the slurry was consumed and the level went down, the slurry tube would be inserted

another 8 by 8-in. piece, E. This will constitute the front board. This front board is so cut that it fits in between the sides of the box instead of on the ends, as does the back. In the top, cut a square hole for ventilation. A hood is provided over this hole to prevent light being thrown forward.

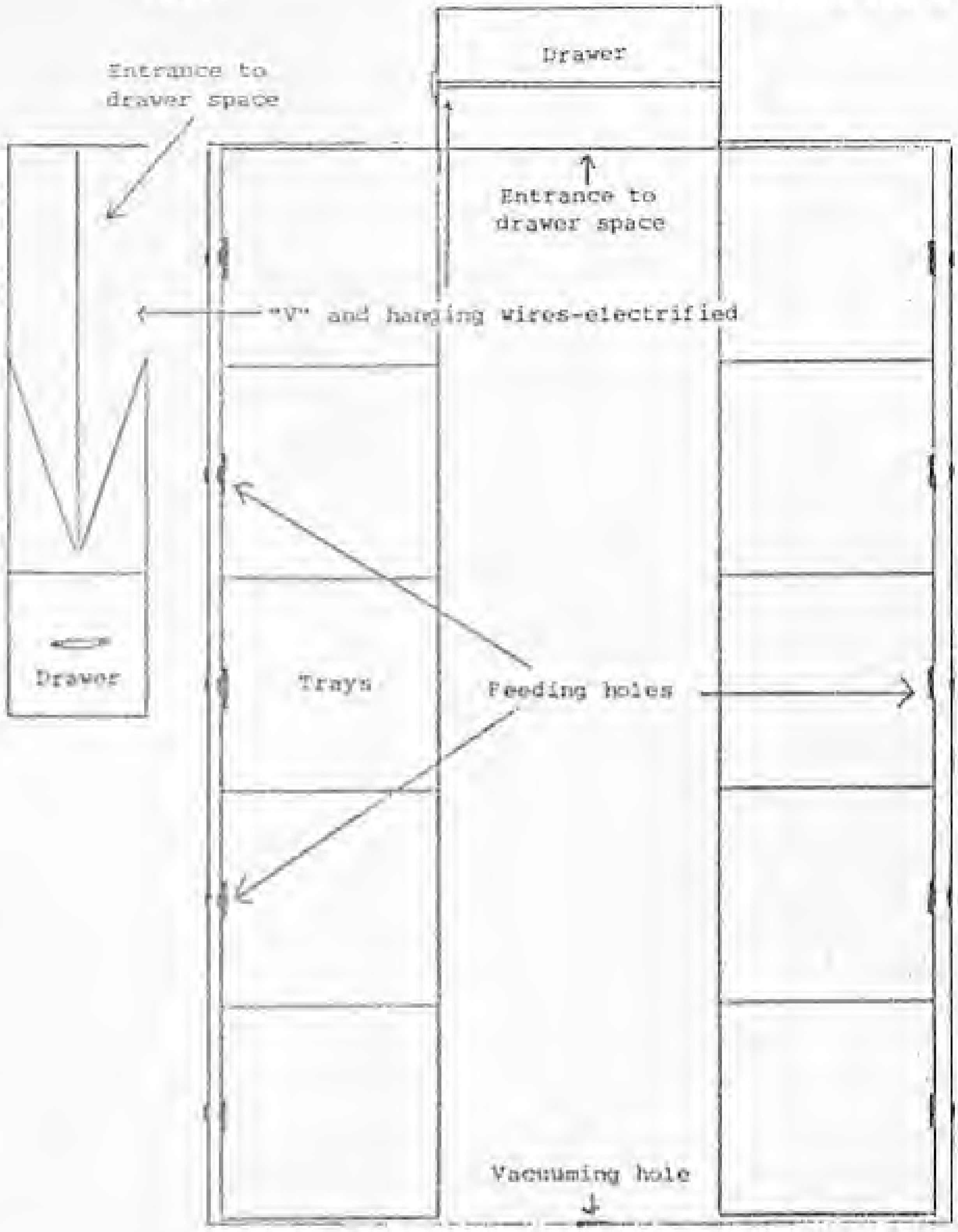
When using the arrangement as a projector or magic lantern two 40-watt tungsten lamps, A, are required. Each lamp is mounted in a porcelain receptacle held on the floor with screws. A lamp cord, one end connecting the two lamps in multiple and the other fitted with an attachment plug, passes through a hole in the floor of the box. Form the two reflectors, B, of 8 by 7-in. bright tinned sheet-iron pieces, each having holes along one of its edges to admit of attachment. The reflectors are bent to a semicircular contour before mounting. The card holder is detailed at C. It is a piece of tinned sheet iron bent to the form shown so that it will hold a post card. A hole is drilled in its center for a screw pivot. It can then be fastened to the center of the back door and can be turned into position for either horizontal or vertical pictures. A washer is inserted on the screw between the holder and the door. The thickness of the camera body having been determined, a slide is fastened to



An Ordinary Small Camera, Fitted with This Attachment, Becomes an Enlarging and Post-Card Projecting Camera

the front board, as diagrammed, to support this body.

Before it can be used as a projector it must be adjusted to operate with the camera of the type and size available. The adjustment, which must be made in a darkened room, having on one of its walls a white screen on which the image will be projected, is effected thus: Remove the back from the camera and place the camera in the slide without extending the bellows. Open the shutter. Insert a card in the holder C. Light the tungsten lamps. Now move the front board, with the camera carried on it, back and forth within the box until the components are in focus,



through both rubber patches into the bottom half of the tray. Starting at the far end of the tray, the tube would be worked from side to side and withdrawn as the slurry welled up through the holes and caused the top level of slurry to rise, refilling the tray.

At one end of the screened-in fly room would be a screened section two feet wide by four feet long, at the bottom of which would be a drawer covering that area. Hanging from its center would be s system of electrified wires too close together for a fly to get through.

Flies touching the wires would be electrocuted and would drop through the slit of the electrified screens making a "V" just above the drawer. There would be a three eigths of an inch slit at the bottom of the "V" so the chances of a live fly getting into the drawer would be small.

There would be little reason to enter the fly room. At the end opposite the drawer would be another slit rubber patch for inserting a ten foot

that is, until the most distinct image obtainable is reproduced on the screen. Then, illuminate the previously darkened room and nail the front board in the position thus determined. These adjustments having been made, paint the box, inside and out, a coat of dead black. Everything should be painted black except the reflecting surfaces of the tin reflectors and the incandescent-lamp bulbs. The front board having been fastened, subsequent focusing can be effected by shifting longitudinally the lens board of the camera. The image of any sort of a picture that will fit in the holder can be reproduced. Colored post cards will project in their natural tints.

To make enlargements with the same box, a few minor changes are necessary. When employed for enlargements the tungsten lamps, which are required for projection, are not used. They may, however, remain in the box and can be disconnected from circuit by unscrewing them a few turns. The negative, or film, which is to be enlarged, is held in the opening E. Where a film is to be reproduced, it is held between two pieces of glass which are fastened to the inside of the front board with small clips. If a glass negative is used, the two additional glass plates are unnecessary. If the negative does not fill the opening in the camera, a mask cut from heavy black paper will be required to cut off the light.

The light for the enlargement is furnished by another tungsten lamp mounted in a porcelain receptacle which is screwed to a board which constitutes a base. This light source is moved about in the house until it is directly back of the opening E in the front of the box and until the light is distributed equally over the entire negative. To focus, move the camera backward or forward. While focusing, use a yellow glass, or ray screen, to cover the lens. When focusing has been completed, the shutter is closed and the ray screen removed. Then stop down the lens to bring out detail, and expose.

Noodles

After you've made homemade noodles, you'll wonder why you ever bought the flour and water kind. That's all the commercial ones are made of. Your homemade noodles are made of flour and eggs. They are basically 2 eggs, 1/4 cup butter, or margarine, a dash or two of salt and enough unbleached flour to make a stiff dough. Roll out the dough, cut into narrow strips, separate them and spread them out to dry. (If your noodles are really bone dry, you can put them in a jar and they'll keep a month.) For a cheap addition to a meal, serve plain egg noodles with butter or cheese. They are great with chicken or beef stew or vegetable soup.

long tube to vacuum out any flies dying naturally.

If the unit were properly maintained, the drawer should be filled with dead flies several times a day.

Although flies are known to be carriers of germs, this is only because wild flies seek decaying matter for food and for egg laying. These domesticated flies, feeding and laying their eggs on the nearly sterile slurry would be as germ-free as one could reasonably want.

My system is for producing in bulk to feed commercial flocks or to sell. But it could be scaled down to fit the needs of the individual.

Nor would one be confined to human waste. Any manure, chicken, rabbit, pig, cow, horse, etc. would do. For a clean product, however, it is urged that the manure first be subjected to the methane extraction process. This would not only provide free gas for the house but would produce a finer, cleaner slurry for the flies.

ENCYCLOPEDIA BRITANICA 1892

THE HOUSE-FLY

The minute dull chalky white eggs (usually about 120 in number), elongate oval and cylindrical in shape, are laid by the parent fly in crevices of fresh manure in or about stables,—heat, and especially moisture, being required for their development. The larvæ are hatched in twenty-four hours, and pass through three stages, averaging from five to seven days in all; in the second of its stages, the larva has been observed to increase by one-third of its length in twenty-four hours. They resemble those of the well-known meat fly, *Calliphora vomitoria*, but are smaller, longer, more slender, transparent, smooth, and shining, and regularly conical. The prop-leg at the apex is also much smaller, and cannot be seen from above when the larva is in motion. They eat the decaying parts of the manure, leaving the bits of hay and straw. The puparium, or pupa-case, is a quarter of an inch long, cylindrical, and dark brown, closely resembling that of *Stomoxys calcitrans*, from which it chiefly differs in the larger and squarer anal spiracles and the smoother apex. The enclosed pupa is of the usual type of the cyclorhaphous *Diptera*, and is readily distinguishable from that of *Stomoxys* by its broad spatulate labium and curved maxillary palpi; it rests in the case with the hard framework of the jaws of the old larva skin next the ventral side; and when the fly pushes its way out, after remaining from five to seven days as a pupa, the upper end of the case splits off just behind the suture between the thorax and abdomen. The term "pupa" is here used in a general sense, since intermediate stages of development (variously called "pseudo-nymph" or "semi-pupa") in that condition, occur in the *Muscidæ*, as in *Hymenoptera*, *Coleoptera*, &c.

On leaving the pupa-case, the fly runs about with its wings soft, small, and baggy, pressed to the side of the body, ma[illegible] as in the pupa. It is pale, with the colours not set, and the membranous portion of its forehead constantly distends with air as the fly moves, being connected with the tracheæ. From Mr Lowne's observations on the anatomy of the blow-fly, this organ is evidently employed for pushing away the end of the puparium when

A two-story house for rats

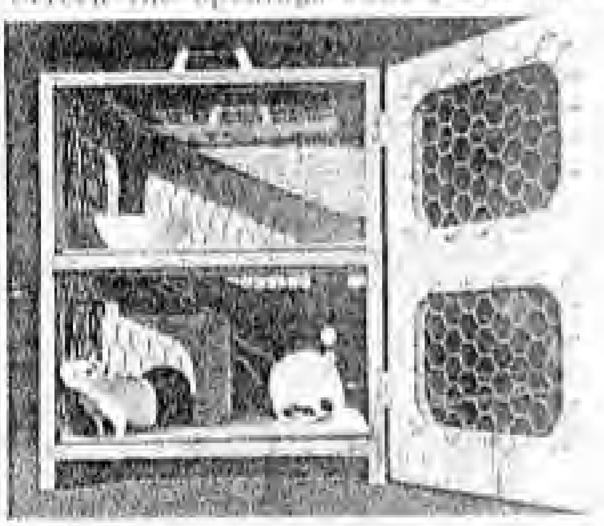
SUNSET March 1969

The white or hooded rats you see in pet stores are delightful little pets for children. They are very friendly in a shy way, intelligent, and unusually clean animals. They do need a cage they can call home.

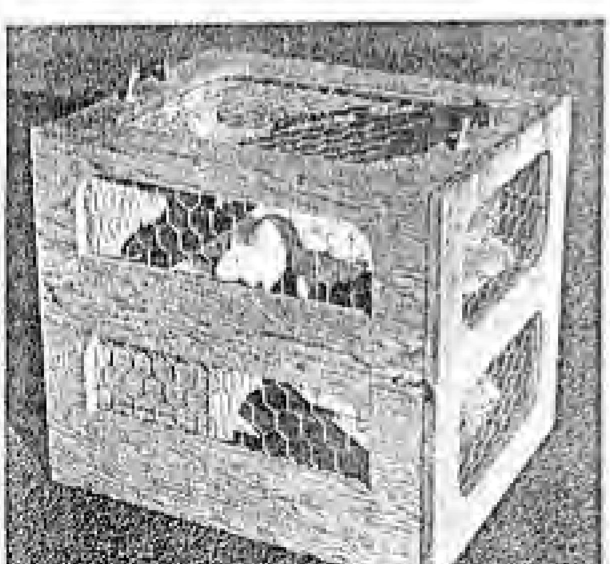
Ronald G. Lyman of Salem, Oregon, designed and built this simple cage to house his children's two white rats. It has worked very well. The cage is small enough to be moved about easily but big enough to allow the rats to exercise inside; it has hideaways for sleeping and windows at two levels for viewing the world.

You can build this cage of ½, ⅝, or ¾-inch plywood. Cut the openings in door, side, and top with a saber saw, jigsaw, or hand keyhole saw. The left and right side of this cage are rabbeted to hold the two floors and the top. If you do not have a power saw, simply butt join these wood members. Use glue as well as nails when assembling.

Screen the openings with 1-inch mesh



Seemingly happy *in their home, these white rats don't rush away when door is opened*



Two handles *make for easy carrying. Wire-mesh windows let the rats see all, smell all*

the pupa slips out of its case.

The whole period of evolution being thus from ten to fourteen days only, and the number of eggs laid by each female fly so numerous, it will be readily seen that any slight personal inconvenience to man, as produced by the habits of the perfect insect, are much more than compensated for by the unceasing labours of its larvæ as scavengers; the benefit being the more direct as the work is invariably done close to human habitations. The workings of the law of nature, by which an excess of increase in any one species is checked, are conspicuously shown in the case of this insect. Not only do the ordinary parasites of its own class (some Hymenopterous, and in one recorded instance Coleopterous) attack it in its earlier stages, but certain common birds are particularly addicted to it in the perfect state (in which also a *Chelifer*, a minute European representative of the scorpions, has also been found parasitically attached to it). The vegetable world also supplies some lethal agents in the shape of fungi (notably *Empusa muscæ*), individuals destroyed by which are constantly to be seen in autumn unable to move, and distended or ruptured by the expansion of the internal growth, the white spores of which are finally to be observed scattered round their victim.

Trivial as the house-fly may appear even to entomologists, it is to be noted that recent observations by the German biologist Weissman on its development have resulted in his discovery of its possessing "imaginal discs" in the early larval state—a structure deemed of sufficient value to suggest a new division of the whole *Insecta* into "Discota" and "Adiscota."

MAKE YOUR OWN CORN NUTS

You must be familiar with corn nuts. They are put up in plastic snack bags and are sold in most gas station markets. They cost about 25 cents an ounce and are made from Hickory King Corn, a larger type than feed corn.

The only difference between Hickory King and other varieties is the size. There is no difference in taste. So you can make all the corn nuts you like and be assured they are just as good as the commercial kind and cost next to nothing.

Corn nuts are a variation of parched corn. Indians and pioneers ate parched corn almost as a staple while traveling. It was very nutritious and took up little space so was considered an excellent trail food.

Parched corn was made by Indians by putting dried corn on hot rocks or in hot coals. You can make parched corn by simply covering the bottom of a greaseless frying pan with corn and stirring until the kernels are uniformly brown.

Corn nuts are a little more refined. As a sample batch, use one cup of whole corn, bought from any feed or health food store. Soak the kernels in two cups of water for three days, in the refrigerator.

Pour off the water and dry the kernels in a towel. Heat up about four cups of grease; bacon,

Potato Chips

Pare the potatoes and slice into thin shavings with a vegetable cutter. Let them soak in ice water for an hour, drain and dry in a towel. Have ready your heated deep fat and fry until they curl and are lightly brown. Put them in a wire frying basket to immerse in the fat and shake them as free of fat as possible before lifting from the kettle, then put to drain on absorbent paper. Dust with salt. Keeps a week or more.

Pretzels

Make a dough of four cups of flour, 1 tablespoon butter, 1/2 teaspoon salt, a rounded teaspoon dry yeast, enough water to make a rolling dough. Let rest 20 minutes, then roll out and cut into strips and let dry a couple minutes. Shape into pretzels pinching ends together. Let stand until they begin to rise.

Make a solution of one level tablespoon of lye in a half gallon of boiling water or 2 tablespoons in a gallon (don't use aluminum pans). Put the pretzels in the boiling water. As soon as they come up to the top take them out. Drain, brush with beaten egg yolk, sprinkle with course salt or caraway seed. Bake on oiled baking sheet. Set oven as high as you can, 700 if possible and leave in there 2½ minutes, (10 minutes at 500). Take out of the oven, turn down to 400, set them back in and leave in until they are bone dry. Drying time varies a lot by how they are cut out, how thick they are. Break into desired lengths. Put into jar with tight lid and they'll keep.

lard, vegetable oil; it doesn't matter. When it is so hot a drop of water sputters on its top, lower a heaping tablespoon of kernels into the middle of the grease. The grease will then begin to boil violently. You have to know how it will react so you won't be tempted to just dump the whole cup in and watch the grease erupt all over the stove.

Make sure any handle to the container is turned toward the back of the stove, especially if you have a child standing by. Also, stand back as an occasional kernel will pop like popcorn.

At first the kernels will sink to the bottom and most will rise to the surface as their moisture departs. When they float to the surface watch until they turn copper brown.

Take out a kernel occasionally, let it cool a minute and chew it. If it's chewey it's not done. When it crunches and shatters it is. Then scoop the browned kernels out onto a piece of newspaper to absorb the grease.

Now you can continue a heaping tablespoonfull at a time and cook them about three minutes or, cautiously and slowly pour the rest of the cup in. After the boiling stops the kernels will rise and simmer on top. But the whole cupfull will cause the grease to cool some so the real cooking will take about fifteen minutes.

All you're doing is deep frying them. You can experiment with a shallow frying pan or a deep fat cooker. The result will be the same. With salt, they will be delicious.

Don't use the same grease for more than three or more batches. The heat breaks down its molecules in time and it can be unhealthful.

You might also try deep fat frying soybeans. They are tasty but not so much as corn nuts. Soybeans need only be soaked overnight. Also, they cook in a shorter time and are lighter than copper brown and do not become exactly crunchy; something between chewy and crunchy. Munchy. Tasty with salt.

Both corn nuts and deep fried soybeans can be mixed for party snack bowls or while watching TV.

SAVE THE FAMILY FARM

In the early 1970s Russia suffered disastrous crop failures. Their government blamed the weather and inefficient collective farmers. Bureaucratic bungling was an important factor.

The Russians then bought up all America's surplus grain. Fearing shortages here and hoping for more Russian crop losses, the U.S. government encouraged the American farmer to bring more land into production. Our farmers did as they were asked. Our banks gladly loaned them money for more land, seed, fertilizers, pesticides, herbicides and more and much larger farm machines and the fuel to run them.

For a while the farmers did well. Then the Russins figured that if Americans could get bogged down in a no-win war in Vietnam, they could do as well. So they invaded Afghanistan. President Jimmy Carter, reared as a farmer, nonetheless cut off grain sales to Russia on behalf of the Afghans.

The Russians simply turned to Canada, Australia and Argentina. Also, Russian bureaucrats eased up on their farmers and their own grain production rose.

This left American farmers with millions of acres devoted to grains no longer in short supply and actually a growing surplus, costing the U.S. taxpayer over $9,000,000.00 a day to store. And the American farmer goes on growing

grain without a market until the bank relieves him of his counterproductive farm.

John Redman Coxe, writing in The Emporium of Arts & Sciences, 1812, proposed a crop which might be the solution to those farmers who have not yet gone bankrupt. Sunflowers are a temperate crop. They will grow well on marginal land without irrigation. After planting they need no cultivation and with modern agricultural methods should be double the production of 1812.

Sunflower seeds, oil, seedcake, cordage, etc., would give the farmer a much higher profit than grain. This is especially true since they require no fertilizer, pesticides, herbicides or post-planting cultivation.

Observations on the Various Uses to which the Sunflower may be applied. By the EDITOR.

THE advantageous employment of this plant does not appear to have been sufficiently appreciated. The object of this essay is to attract the attention of those who may have it in their power to pursue the enquiry to its full elucidation; and it is expected, that this may be readily accomplished by persons residing in the country, with little expense or trouble to themselves, and with real benefit to the community, if their experiments shall satisfactorily demonstrate the presumed merits of this very common and luxuriant product of the vegetable kingdom.

In a letter, published in the first volume of the American Philosophical Transactions, from Dr. Otto of Bethlehem to Dr. Bond, we have an account of the oil produced "from the seeds of the common large sunflower," by methods very similar to the extraction of linseed oil; one bushel of the seeds yielded about three quarts of oil; and he states that it was frequently used on sallad, for which it answered very well. The committee, to whom the specimen sent was referred, report it to be thin, clear, and agreeable to the taste, and are of opinion, that it "will supply the place of olive oil for the above, and many other purposes; and may, therefore, be looked upon as a valuable discovery to America.

Immediately following this communication, is an essay by Dr. J. Morgan, "on the expressing of oil from sunflower seed," in which we are informed, that it is found from experiments, that a bushel of the seeds will yield, on expression, near a gallon of mild oil. And he gives the account, from a correspondent at Lancaster, of certain results upon this subject, from which we learn, that one hundred plants, set about three feet distant from each other, &c. "will produce one bushel of seed, without any other trouble than that of putting the seeds into the ground, from which he thinks one gallon of oil may be made." "By an estimate made, it appears, that one acre of land will yield to the planter between forty and fifty bushels of seed, which will produce as many gallons of oil." The remainder of the essay is taken up with many valuable observations on the mode of expression, and on other points connected with the subject, which are unnecessary to be here transcribed, since the whole of the original communication will be advantageously read, by any one who finds an interest in the present essay.

Mr. John Saunders, of Gloucestershire, (England) has called the attention of the public, in Dickson's Agricultural Magazine, No. 6, to "the use of the seed of the great sunflower, (Helianthus annuus) as a food for swine, rabbits, poultry, &c." in which communication he reckons that an acre will produce from fifty to sixty sacks, (weight of sack not mentioned,) the profit of which, at the low rate of two shillings and sixpence per sack, is estimated at four pounds sterling per acre. He remarks likewise that the stems partake so much of the nature of wood, that, when perfectly dry, they may be burnt as fuel, an acre affording from three to nine waggon loads. He suggests also their use by wattling and other modes, to enclose sheep, and to guard them from the inclemencies of the weather; and that, where there are dry walls, with the aid of rafters and hurdles, they might be converted into an excellent covering for temporary sheds in the fields, and about the homesteads, for pigs and other animals. He recommends the leaves as an excellent green food for rabbits, or as serving for litter when dried. The plants, too, he affirms, will remain a long time after they are ripe, without shedding their seeds, through neglect of gathering, and are not liable to be injured by rains, or destroyed by the attacks of birds. He mentions the cultivation of the plant in France for the sole purpose of extracting an oil; and he recommends sowing the seeds very early in the spring, if not in December, as the early sown plants always arrive at the greatest height, and produce the largest quantity of seeds. The whole paper is worthy of perusal.

The mode of culture is given in the same magazine, No. 7, by "Amicus," from Dr. Willick, and Mawe and Abercrombie's Gardener's Calendar. This person states the use of the oil in *printing*; and of the *cake*, after expression of the oil, in feeding a pair of small oxen, who eat it greedily, and throve well upon two pounds a day. He farther states the oil to be as fine transparent sweet oil as ever was produced from almonds; and that eighty pounds weight of clean seed produced eight quarts of oil, part of which he used in lamps, and found it burn with great pureness and brilliancy.

In No. 9 of the above mentioned magazine, a writer conceives, that it may be successfully cultivated for the purpose of supplying clothiers with oil, instead of using

the Florence oil imported from the Levant, and which is sold to them when it becomes rancid, for the purpose of softening their wool, when preparing for the loom.

We have another writer on the subject in the 27th No. a Mr. John Wright, who estimates the crop produced by him at not less than twenty quarters of seed to the acre; though he considers it a tedious crop to harvest, from its ripening at so many different periods: he nevertheless appears to think well of it upon the whole.

I have thus collected a mass of facts, which altogether, I think, render this plant worthy the attention of the farmer, and afford adequate encouragement to a fair trial of its real importance, in affording a most important article to the painter, printer, clothier, and in domestic economy; both as a fuel and for diet. I come now to what, I trust, may prove of far more value in a national point of view: I mean the great strength and staple of the woody fibre of the stalk of the sunflower, a part not heretofore applied to any use, except as above proposed by Mr. Saunders.

When we consider the immense importance of the article hemp to our maritime concerns, (other objects of its application out of the question,) and recollect what sums are annually expended in Russia in the purchase of this raw material; when we reflect, too, on the comparatively small proportion of our wants supplied amongst ourselves, partly arising from the trouble and uncertainty of the crop, and more, perhaps, from other articles of husbandry being more productive: we must admit, that if a fair and adequate experiment shall prove, that a plant, attended with little trouble in cultivation, and almost certain in its produce, is capable of affording a substitute for hemp, of equal or even superior strength for manufacturing ropes, cables, &c. of such infinite importance to the commerce, &c. of the United States;—I say, if this is demonstrated by fair experiment, who will doubt its becoming an article of the first attention in agricultural pursuits? The chief object of this essay is to call upon our farmers and others, especially those who are accustomed to raise hemp, to give this a fair and candid examination. In towns, we have not adequate advantages to pursue this enquiry; but it is now several years since I accidentally found a sunflower standing in my garden, of which little remained but the woody fibre, (the rain, &c. having gradually rotted off the epidermis, &c.) which resisted so much my attempts to break it, that I was forcibly struck with the probable advantages to be derived from its use. Since that time I have repeatedly mentioned the fact, and have endeavoured to induce others to pursue the enquiry, but, I believe, without effect. My attention has been again called to this subject, by lately stripping off a small and single fibre from a plant, and twisting it once or twice into a small twine, which I could not with all my force break, otherwise than by repeatedly bending, so as gradually to destroy the cohesion of the parts; even the *single* fibre would, I believe, have supported a weight of some pounds. Under the impression I have, I consider the medium of the Emporium the best, by which I might hope to have a full and fair experiment made upon a point so truly important, and I have only to request the favour of any one who pursues it, to let me know the result, that I may communicate it to the public.

Before I conclude, I shall only add, that the *pith* of this plant, which is very considerable, is, without exception, one of the most combustible materials I know. A piece of seven or eight inches in length, from one of the branches, perfectly dry, catches fire like tinder, and burns down in less than a minute. Whether experiment may show it to be useful as a match, in blasting rocks, instead of the present kind employed, I know not; probably we may find it useful in this, as well as in other pursuits.

JOHN REDMAN COXE.

Philadelphia, October 5, 1812.

10,000 POUNDS OF TOMATOES!

In Japan, in a glass-enclosed shopping mall, is a single tomato plant about 20 feet tall. So far, it has yielded 10,000 pounds of tomatoes.

This is an example of what just one plant, properly nurtured can do To understand this you must put aside your notions of garden plant yields.

The garden plant is subject to changes in weather, water, competition for nutrients and other factors which limit yields. Also, most garden plants die with the first frost. But a plant raised in a greenhouse, whether in soil or by soilless culture (hydroponics) doesn't have the limitations of garden plants. It gets plenty of everything it needs and on an individual basis. Since it is protected from extreme cold, unless it naturally dies after producing seeds, it can keep

growing indefinitely.

The only real difference between soil and soilless culture is that with hydroponics, you provide all the nutrients. This takes a little more study. But once you've gotten the right combination of chemicals for a specific plant, it's just routine from then on.

If you should decide to make a growing cabinet, as described on the following pages, one tomato plant could pay for your unit and give you pocket money or more, depending on the size of your operation. After all, tomatoes sell for up to 90 cents a pound. If you should sell them to friends and neighbors, or possibly a store, you could build up a steady income. You could charge up to 50 cents a pound to individuals and sell all you grew.

Of course, you would have to trim your plants lest the foliage swamp the unit. You might not get five tons from one plant, but you could make a decent profit and become an asset to your community.

Since I don't know what kind of tomatoes you want, or even if you might choose eggplant, hot peppers or other vegetables to grow, I suggest you get a Gurney's seed catalogue. They are free and the best, in my judgement. Write to Gurney's Seed Co., Yankton, SD 57079.

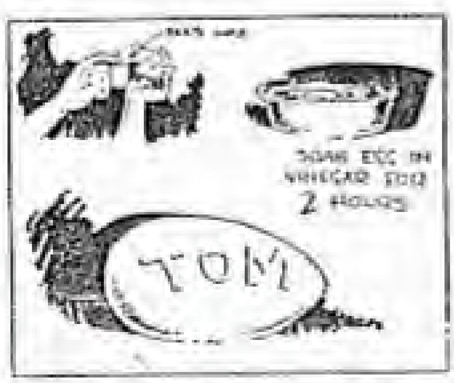
For a good, overall plant nutrient which should satisfy you until you become more selective, I suggest Miracle-Gro. This sells at $12.95 for five pounds. One tablespoon to a gallon of water will give most plants all the basic and trace elements they need.

FUN FOR BOYS AND GIRLS

By Cappy Dick 1942

YOUR NAME ON AN EGG

Beeswax And Vinegar Will Produce This Amazing Result



How would you like to amaze your friends by showing them an egg with your name or initials actually engraved in raised letters on the shell?

You will not only mystify them, but you will be the envy of the whole gang. Imagine the fun you can have by claiming to have among the chickens a special friend that will lay an egg dedicated to you!

Ask Mother for a little piece of beeswax, the kind that is used to make a flatiron smooth.

With this, write your name or your initials on the shell of an egg. Press down, so plenty of beeswax sticks to the shell.

Next, place the egg in a bowl of vinegar. Leave it there for about two hours.

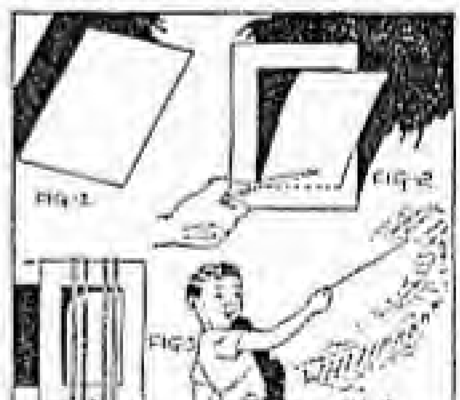
When you remove the egg from the vinegar you will discover your name has appeared in raised letters on the shell!

This happens because the acid of the vinegar eats away that part of the shell not covered by the wax.

Show the results to your friends.

RUBBER-BAND MOANER

Whines When You Whirl It Around Your Head



A piece of cardboard about six inches long and four inches wide (Figure 1) and four rubber bands are required to make a rubber-band moaner.

With scissors or a sharp knife, cut the center out of the cardboard as shown in Figure 2, leaving a frame about one inch wide at the top and bottom and three-fourths of an inch wide at each side.

Punch a small hole in one end of this frame and tie a long string to it.

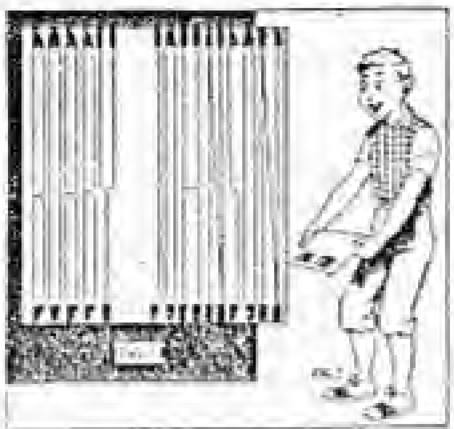
Over the frame stretch the four rubber bands as shown in Figure 3. The moaner is now ready for use.

Take hold of the free end of the long string and begin to swing the moaner around and around, going faster and faster. Soon you will begin to understand how this toy got its name, for the rubber bands will begin to moan as the air swiftly passes through them. The faster you swing the moaner, the higher the pitch of its sound.

The results can be improved, if you wish, by slipping a small piece of wood beneath the rubber bands at each end of the cardboard frame, thus moving them away from the frame and placing them more in the current of air as the moaner is whirled.

SKELETON PRINTING

Your Name Can Be Read Only From A Certain Angle



If you'd like to have a new way to print your name, try this fun-project. The method is a good one to use when putting your name in your books and it's also a lot of fun just to draw it on a piece of paper and show it to others to see if they can tell what it is.

In Figure 1 appears the name of a boy. It is difficult to read, but if you hold this book as the boy in Figure 2 is holding his paper, with the surface of the page level with your line of vision, you will discover that the letters are quite legible and spell the name "Bobby Johnson." Try it.

If you would like to print your name in these elongated letters, the secret of doing it so that it will be hard to read when looked at in the customary fashion is this:

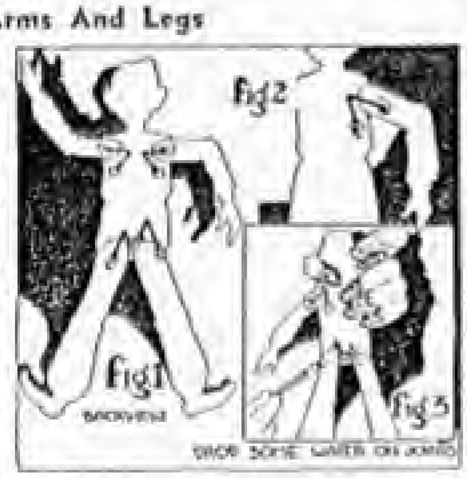
Make each letter very, very tall and thin. Make the top and the bottom of each letter thick and black. Print the letters close together.

If you follow these directions, your name will not be legible except when viewed with the paper held flat before your eyes.

Learn how to print this way and then show the other boys and girls at school. They'll want to try it, too.

GROWING PAINS

A Cardboard Man Who Stretches Arms And Legs



Growing Pains is a funny fellow. If properly put together, he will move his arms and legs in a great stretch, as though he were trying to grow very tall.

First cut out Growing Pains' body (with head attached) and then two arms and two legs. Use lightweight cardboard or a very heavy paper.

To attach arms and legs to the body you must have four toothpicks. Bend each one in the middle so it cracks, but does not break in two. With sealing wax or a very small bit of chewing gum affix one end of the cracked toothpick to an arm and the other to the shoulder of the body as shown in Figure 2. Fasten on the legs in the same manner. When you have done so, the rear view of the completed figure will be as in Figure 1.

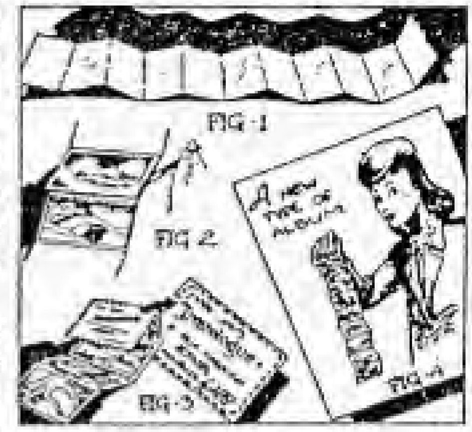
To make Growing Pains move his arms and legs in a very amusing manner, simply dip a water-color brush into water and place a drop of the water on the break in each toothpick, as in Figure 3. Put Growing Pains face-up on a table. In a twinkling he will stretch his arms upward and his legs outward. This takes place when the water swells the toothpicks and makes them straighten out. When the toothpicks have dried again, bend them back to their original position and Growing Pains can again be made to move his arms and legs.

JAW-BREAKERS

Five fine flame-colored flamingoes flew from Florida.
Gordon's great gray goats gazed gloomily groundward.

POSTCARD TRAVELOGUE

A New Way To Show Your Scenic Cards



Do you collect picture postcards showing scenes of cities and other places around the country?

If you do—and it's a good hobby for any boy or girl—why not produce your own movie-style postcard travelogue?

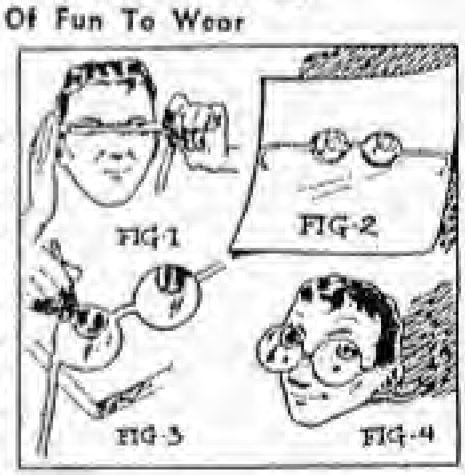
The travelogue can have a cover on it resembling the title on a piece of movie film (Figure 3), and it is great fun to show it to your friends when they come to visit. Furthermore, it is a dandy way to preserve your collection of cards in a neat and unusual album.

The first thing to do is to divide your cards into subjects, if you have many of them. They can be sorted, for example, according to the states from which they came, so that you will have a pile of cards showing scenes of Iowa, another showing scenes of Illinois and still another showing scenes in Texas. If you have some showing scenes in the various national parks, they will make still another group for a single travelogue.

Get a strip of wrapping paper just a little wider than a postcard and long enough to accommodate all the cards you have in a given group. Fold this strip as shown in Figure 1. Each section of the folded paper must be large enough for a postcard to be glued upon it and still allow room for the paper to fold readily. Figure 2 shows how to glue the cards in place and Figure 3 shows how to decorate the back of the top flap (which will fold over all the cards) with the title of the travelogue. Figure 4 shows what the travelogue will look like when fully opened for inspection.

HOME-MADE GOGGLE-EYES

They Are Lots Of Fun To Wear



Make yourself a pair of big, funny goggle-eyes.

It's easy to do with heavy, construction paper and crayons. In a jiffy you can cut out a pair of false spectacles that will fit over your nose and ears. On the spectacles are big eyes drawn with crayon. Round holes cut in the eyeballs of the false eyes will enable you to see as you walk around with the goggle-eyes on your face.

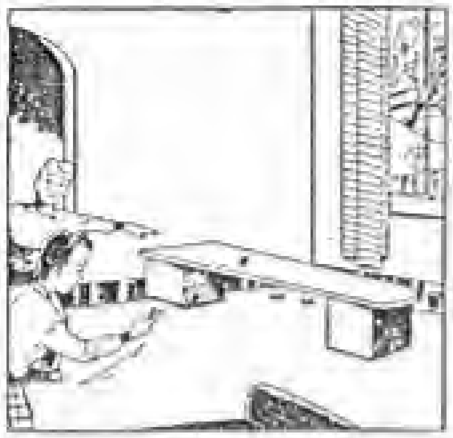
Figures 1, 2 and 3 show how to make the eyes so they will fit. Begin by measuring the distance from one side of your face to the other across your eyes, as the boy in Figure 1 is doing. This will show you how wide the paper glasses should be to fit you. Next, measure the distance along the side of your head from a point paralleling the bridge of your nose to the back of your ear. This will show how long the ear frames should be. You must now have a piece of light-colored construction paper out of which to cut the goggle-eyes.

On this paper, with pencil, draw the outline of the glasses and the ear frames, as shown in Figure 2. Next, with scissors, cut the glasses out, letting the ear frames be wide, so they will not tear easily when bent and hooked over your ears. Bend the ear frames back at the place where they join the eye frames and then with crayons draw the big eyeballs on the glasses. Punch a hole as large as a dime in the center of each eyeball so you will be able to see through the paper when the glasses are on.

The finished effect will be similar to Figure 4.

OVER THE BRIDGE

Played With Checkers And Ironing Board



If you have some checkers and can borrow Mother's ironing board, you can play a game called "Over the Bridge." It is a game for two players and you must have two red checkers and two black ones.

Place two large boxes on the floor about three feet away from a wall. Put the ironing board on top of the boxes so that a bridge is formed with one box under each end of the board.

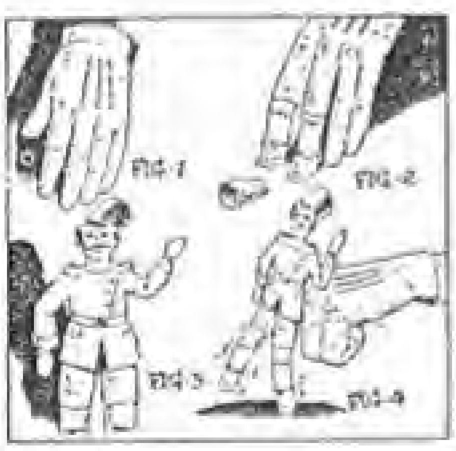
Next, establish a taw-line 10 feet in front of the board. Each player must stand with the toe of his foremost foot back of this line and pitch his checkers over the ironing-board bridge.

The object is to see which one of the players can cause his checkers to sail over the bridge and come to a stop at a point farthest from the wall, but still not under or in front of the bridge. The first player tosses his two checkers and then the second player tosses his checkers. A tape measure or ruler will often be needed to determine whose checker is farthest from the wall. The player whose checker is closest to the far edge of the bridge (and therefore farthest from the wall) gets one point. The first player to get 10 points is the winner.

It is fair to toss a checker so that it strikes the wall, rebounds to the floor and rolls back toward the ironing board, but a checker that rolls back toward the bridge so far that it stops even only partly beneath the bridge, does not score.

DANCING GLOVE-DOLL

Two Fingers Serve As Its Legs



Make a dancing glove-doll!

This is an easy but surprisingly effective fun project for either boys or girls. A glove-doll is merely a cardboard figure glued to the back of an old glove which you place on your hand. Your first two fingers are the doll's legs. As you move your fingers, the doll appears to be dancing on the table top.

The first thing to have is the old glove, preferably one of leather. Be sure it is a glove that is no longer useful.

With scissors, cut off the first two fingers of the glove at the second knuckle (Figure 1).

Now, out of thin cardboard cut the figure of a dancer, but do not include legs with the figure. Just make the upper half of the body. Figure 3 in the sketch suggests a foreign soldier for a dancer. Color the figure with your crayons or your water colors.

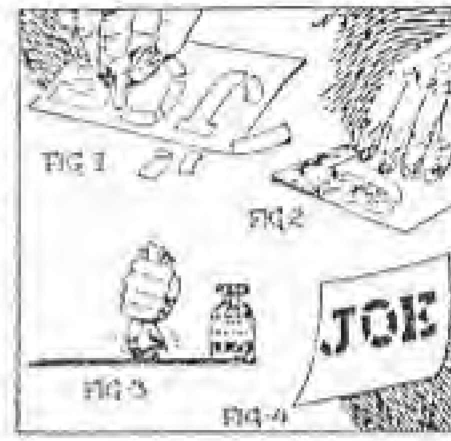
Put the prepared glove on your hand and glue the back of the cardboard figure to the back of the first two fingers, from which part of the leather has been cut away. The result will be as in Figure 3.

Now, get some doll socks and slip them over the tips of your two exposed fingers (Figure 2). Cut the tips off the leather finger-ends you snipped from the glove and use these tips for slippers by putting them on your fingers over the doll socks.

Your glove-doll is now ready. To make it dance, keep your first two fingers extended and double your other two fingers into your fist as in Figure 4. Then, when you push your hand forward and move the first two fingers, as though jigging, the doll will seem to be dancing across the table.

HOW TO CUT A STENCIL

Print Your Name, Initials Or Secret Sign



If you like to print your name on books and other things, you can have a lot of fun doing it with a stencil. It always produces the initials, name and secret sign the same, no matter where they are placed.

To make your own stencil is easy. All you need is a piece of heavy brown wrapping paper (the heavier the better, for thick paper will last longest), a sharp knife, some old rags and some liquid shoe polish.

First, decide what you want to print with the stencil—your initials, the secret sign of your club or the name of your school. Next, with pencil, draw the letters (or sign) on the heavy paper. It is best to make the figures wide. At certain points you must allow little "bridges" to run across the outline of the letter, as shown in Figures 1 and 2, so the paper within the letter will not fall out. A letter "O," for instance, requires at least four bridges to keep the paper within the "O" joined to the paper outside the "O." Otherwise, when the stencil is used, the "O" will appear merely as a big, round dot.

After drawing the letters or the sign, rub both sides of the paper with a generous amount of lard. Lay it aside until the next day, by which time the lard will have soaked through the paper, making it tough and waterproof.

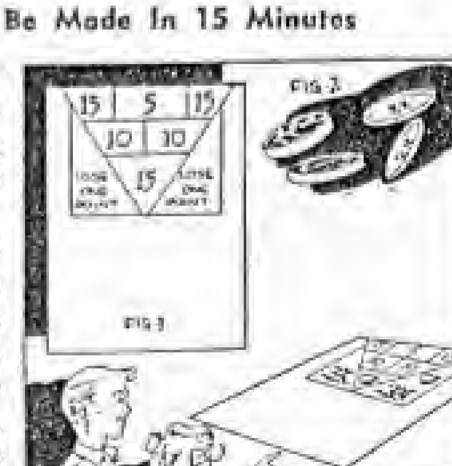
Then, with a sharp knife, proceed to cut the letters out, always remembering to allow the bridges to remain, to hold the inside and outside of each letter together (again study Figures 1 and 2).

After this has been done, make a small ball of old rags (Figure 3) to be used as a dauber. Place the stencil on the object you wish to imprint. Dip the rag ball into some liquid shoe polish and rub this across the letter-openings on the face of the stencil. Lift the stencil and the imprint will appear as in Figure 4.

Try it! It's fun!

TABLE SHUFFLEBOARD

Equipment Can Be Made In 15 Minutes



Anybody who likes to play games will enjoy table shuffleboard. The equipment needed can be made in about 15 minutes.

Get a large piece of cardboard, such as the top of a suitbox. At one end of this cardboard draw a chart as shown in Figure 1 of the sketch. As you can see, there is a triangle which is divided into six parts. Each part has a numeral in it which designates the value. Draw some lines outside the forward point of the triangle. On each side, letter the legend "Lose One Point."

For "men" use buttons or checkers (Figure 2). Each player should have two men. If checkers are used, one player should have two red checkers and the other player should have two

black ones. If buttons are used, have two white ones and two black ones.

Put the game board on a table. One at a time, the players line their men up at the edge of the cardboard, take aim and, with a flip of the finger, shoot a man toward the triangle. The idea is to have the man land on a section of high value.

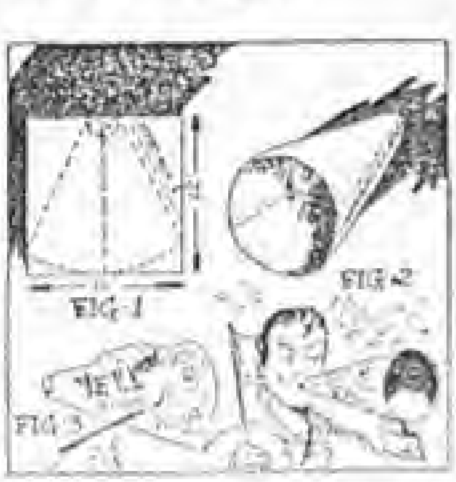
One player shoots one of his men. Next, the other player shoots one man. Then the first player shoots his second man and finally the second player shoots his second man. Then figure out the score for that round.

If a player wishes, he can shoot his man in such a fashion as to knock his opponent's man out of the triangle.

Keep on playing rounds like this until one player or the other has scored 123 points and thus becomes the winner.

MAKE YOUR OWN MEGAPHONE

You Can Decorate It With Crayons



Next time you go to a football game, take your own megaphone with you. It makes yelling lots more fun. Furthermore, it's fun to make and decorate the megaphone just as you want to have it.

You must have a piece of heavy construction paper 16 inches long and 12 inches wide. On this lay out the dotted lines shown in Figure 1. The easy way to draw the large bottom arc is with a 16-inch piece of string for a compass. Make a small loop in one end to receive the point of a pencil. Hold the other end at the exact middle of the 16-inch side of the paper. Then, with the string taut, swing the pencil from one 12-inch side of the paper to the other.

The small arc at the top of the paper in Figure 1 is for the mouthpiece of the megaphone. To make it the right size, place a small dot 2 inches to the left of the exact middle of the top 16-inch edge of the paper. Draw a line from this point to join the left end of the big arc. Do the same on the right side. Then draw a small arc from one dot to the other. On the right side, as shown in Figure 1, allow a strip one-half inch wide for gluing.

Now cut the megaphone out, running your scissors along the guide lines.

Place glue on the extra half-inch strip and roll the megaphone into shape as shown in Figure 2. When the glue has dried, use paints or crayons to decorate the megaphone (Figure 3).

If you find your megaphone lasts through only one game, it is always easy to make another for the next.

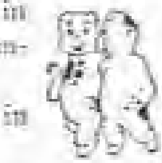
HOW TO TALK PIG LATIN

Any Boy Or Girl Can Learn

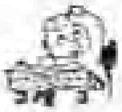
This Fascinating Language

Pig Latin—a fascinating form of double-talk—is easy as pie to understand if you know one or two secrets about it. In no time at all you can learn to read it, write it and speak it.

I think Pig Latin is so much fun that, on pages here and there in this book, I have included some proverbs in Pig Latin. To help you read them and discover what they say, and to help you become a Pig Latin expert so you can talk with your friends in this amusing language, this article embodies complete instructions.



First of all, most of the words in common use in the English language can be readily turned into Pig Latin words. The general rule to follow in making the translation is to move the first one, two or three letters (whichever number will make the Pig Latin word easiest to pronounce) to the *end* of the word and then add the letters *ay*. Thus, the word *candy* becomes, in Pig Latin, *andycay*.



Sometimes with the very shortest words such as *a*, *and* and *or* it is impossible to move a letter from the beginning to the end of the word. In such cases it becomes necessary, for purposes of easy pronunciation, to add *way* to the end of the word, instead of just *ay*.

Practice with simple words at first. Take the word *run*, for example. To translate it into Pig Latin, move the *r* to the end of the word and then add *ay*. That gives you *unray*, which is good Pig Latin.

Try *map*. Move the *m* to the end of the word and add *ay*. This will give you the Pig Latin version—*apmay*.

Take the word *play*. Here's a case where the *first two letters* are moved to the end of the word for the sake of easy pronunciation in Pig Latin, and *play* becomes *ayplay*.

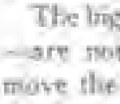
Let's see what happens to the word *desk*. Here you must move only the first letter—*d*—to the end and then add *ay*. That gives you *eskday*, which any Pig Latin expert will understand in a flash.

Try *toy*. Move the *t* to the end and add *ay*. The Pig Latin *oytay* results.

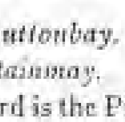
Now let's take the word *and*, in which you can't very handily move any letter to the end. All you do in this case is add *way* instead of just *ay*. This gives you *andway*.

The word *a* must be translated in the same manner. There being no letter that can be moved to the end, you simply add *way* to it and get *away*, which has a real meaning in English but means *a* in Pig Latin.

A similar example is the word *it*. You turn that one into Pig Latin by adding *way*, giving you *itway*, which is easier to pronounce than would be the case if you added only *ay*, making the word *itay*.



Another short word, *to*, requires different treatment, however, and this illustrates the fact that whatever rules are written down for Pig Latin, there are many exceptions. While in translating *it* you move no letter, in translating *to* you move the *t* so that it follows *o*, and then add *ay*. Thus you get *otay*.



The bigger words—those with two or more syllables—are not especially hard to translate. You simply move the first letter or first two or three letters, or the first syllable or two, to the end of the word and add *ay*, or, if the pronunciation becomes easier, *way*.

A two-syllable word is *tomboy*. In Pig Latin it becomes *omboytay*.

Chocolate is a three-syllable word. In Pig Latin it becomes *ocolatechay*. Just the first two letters—*ch*—are moved to the end and *ay* is added to them.

Button, a two-syllable word, becomes *uttonbay*.

Mountain, which has two syllables, becomes *ountainmay*.

An example of the use of *way* at the end of a long word is the Pig Latin translation of *American*, which becomes *ericanamway*. In this case, the first letters—*Am*—are moved to the end of the word and *way* is added because the Pig Latin version is easier to pronounce with *way* than it would be if just *ay* were added to the transposed letters.

So much for the rules of Pig Latin. Actually, the best way to master the language is to start right in using it and make your own rules as you

go along, observing, of course, the few fundamentals universally recognized by Pig Latin talkers. The primary object is to disguise each word so that only those who know the secrets of the pronunciation can understand what you are saying.

Here is a sentence to try as a starter;

Igpay atinlay isway unfay otay eakspay andway itewray.

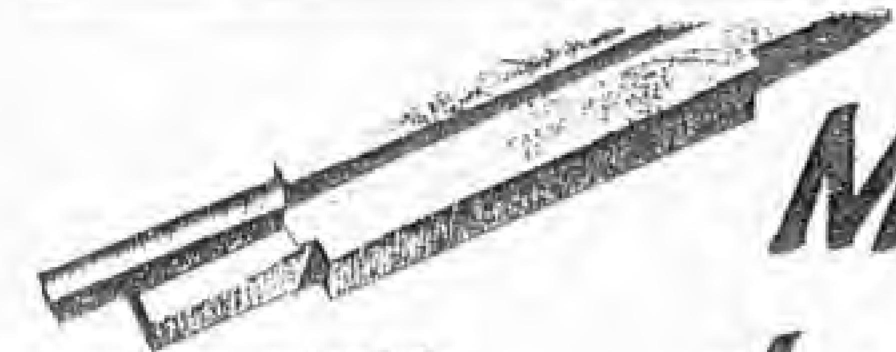
Can you decipher it? It says: "Pig Latin is fun to speak and write."

Now *you* compose a sentence.

PIG LATIN PROVERBS

Indkay eartshay areway oremay anthay onetscoray.
Ethay owhay itateshesay isway ostlay.
Ifway atway irstfay ouyay on'tday ucceedsay, ytray, ytray ainagay.
Ienceexperay isway away earday oolschay utbay oolsfay andway abeshay illway earnlay inway onay'otherway.
Oneymay isway ethay ootray ofway allway evilay.
Allway orkway andway onay ayplay akesmay ackjay away ullday oybay.
Earlyay otay edbay, earlyay otay iseray, akesmay away anmay ealthyhay, ealthyway andway iseway.
Eatgray indsmay unray inway ethay amesay annelchay.
Away allsmay eakday illway inksay away ipshay.
Akemay hayway ilewhay ethay unsay ineshay.

OUTDOOR LIFE NOVEMBER, 1953



Graining knife

Making Buckskin the Indian Way

By CASSIUS H. STYLES

BUCKSKIN has always been, and probably always will be, an important staple of the wilderness. Fashioned into a jacket or hunting shirt, this velvety, buff-colored material will wear for a quarter century. Moccasins made from it are tough and comfortable—requisites for sure-footed stalking that cushion the rustle of dry leaves, and enable one to glide through the forest without breaking a twig.

Yet when we try to learn how buckskin is made—genuine Indian-tanned buckskin—we find we are on a mighty cold trail. Plenty of would-be authorities will gladly tell you just how to go about it, but the chances are considerably better than even that you will end up with a rigid evil-smelling hunk of skin.

Wringing out. Here the slippery hide is being rolled into two big, clammy rings on the stationary pole. Below: rings are being wrung out by turning the free pole

I do, however, know of one master of the craft, Douglas Prior; and the following is his method of processing a hide in the simple yet orthodox manner of the American Indian. Though born in England, Prior grew up in the mountains of California, where his boyhood playmates were the Indian lads of the Sierra Nevadas.

Much of his thoroughgoing knowledge of the woods came from Charlie Seymore, an old frontiersman whose reputation as a maker of fine buckskin still lives among the people of the high ranges. Sixty years ago Charlie hunted with the Pomo Indians, and killed deer with flint-tipped arrows.

Equipment. In making his fine, soft buckskin Prior uses only four pieces of equipment: a small wooden tub, a graining log, a graining knife, and a pair of wringing poles.

The graining log is a round post of hardwood about 10 ft. long and 8 in. in diameter, with 2 ft. of its length at one end peeled and smoothed. This log is lashed or nailed in a nearly horizontal position so that the peeled portion is slightly raised to about waist height.

The graining knife resembles a heavy rolling pin that has been split in half—with a strip of tempered steel, usually from an old butcher's knife, imbedded lengthwise in the flat side. This knife blade should be set in the wood at a slight angle (about 15 degrees) so that one end is higher than the other. The blade should be filed flat like a scraper, with the file held level so that a small, curled-over burr is formed along one edge of the blade. This burr will shave off the grain very effectively, just as a carpenter's scraper removes the surface of a hardwood floor.

Paddling the framed hide. The paddle, rubbed forcibly down the pelt, leaves a velvet-soft white buckskin in its wake

WRINGING poles are merely a pair of 5-ft. lengths of sapling, 2 or $2\frac{1}{2}$ in. in diameter. Do not use square lumber, or poles from which all knots and projections have not been completely smoothed off, as they will cut the hide.

Skinning. Let us hope you have just brought down a good, red summer buck. If his coat is shedding and the blue coat is beginning to show through, you will get an even better, thicker buckskin. In summer, Prior says, the hair is lightest and the hide heaviest;

Wringing stretches the hide into the damp, gray loop below—about 1 ft. in diameter

in winter, the reverse. Winter skin is so thin that in graining the knife is liable to push right through and make holes in your trophy.

Rule No. 1 in making buckskin is to keep the raw pelt clean at all times—dirt will go through it like ink through blotting paper. Smudges, or blood that has dried on while the pelt is still soft, can never be cleaned off. The Indians always kept their skins on a blanket or on ground well carpeted with clean leaves. Also, do not expose the skin to the sun, especially if there is any tallow or fat on it. Under such conditions, sunlight will rot it in an hour or two.

If you can begin work on the skin while it is still warm you won't need to go through the process of raising the grain; it can be both fleshed and grained then and there. Old-time hide hunters did just this and were able to save themselves considerable time, and also make the hide into quite a small package. Probably, though, you will not be able to do this, and anyway, fleshing and graining are much easier after the hide has been properly soaked.

Soaking to raise the grain. The sooner the hide can be immersed in the small tub, in a solution of water and hardwood ashes, the better. Stir in ashes until the liquid feels good and slippery between your fingers. (Babbitt's lye can be substituted for the ashes. Use just enough to make the water slippery—about one heaping tablespoonful.) Be sure that the entire hide is completely under water. Use clean stones to hold it down, for if the pelt comes in contact with the air, bacteria will form and your buckskin will be smelly and retain but little of its inherent strength. Keep all parts well covered and it will not smell at all.

WHILE soaking, hide should be stirred around occasionally and the wrinkles pulled out so that the solution reaches every part. After two or three days the grain should be puffed up and whitish. Test the hide by pulling at a tuft of hair. If it comes out easily the hide has been soaked long enough. If not, put it back in for another day or two. In cold weather you may have to soak it even longer.

Fleshing. Now the real work begins. Lay the pelt on the smooth part of the graining log, flesh side up and neck hanging down so that it overlaps the butt of the log. Then, with a gunny sack tied around your waist, press your stomach against the end of the log so that the overlap is held firmly as you shove the graining knife away from you. Hold the knife firmly but sensitively in both hands, work away from the neck, and scrape all flesh and fat from the surface. If the deer was carefully skinned this won't take twenty minutes.

Fleshing and graining. Flesh and fat are scraped from one side, "grain" from the other

Graining. Next take the hide by the neck and again lay it along the log, this time hair side up. Hold the knife just as you did in fleshing, pressing down and away from you, but very carefully. It is difficult to explain just what graining is, but perhaps I can illustrate by a simple example: In tightening a nut your wrench slips unexpectedly, your hand smashes against a corner of steel, and you skin your knuckles. That is, the epidermis is scraped off and hangs loosely over the tender, pink, but uncut underskin. You have, to use our present terms, grained your hide; and this is just what you must do with the deer hide—being most careful not to cut into the white layer of skin beneath.

Here, you will probably have either to sharpen or to dull the blade of the graining knife, and to change the angle of the square edge by filing, until it will scrape the hair and grain off fairly easily. Trial and error will tell you when the blade is of just the right sharpness. (It is wise to do this experimenting on a leg, which you will cut off and throw away later on, anyway.) When the graining is made with

Finally, sewed into a loose cone and pegged down, the buckskin is smoked over oak chips

a properly sharpened knife, and with just the right downward and forward pressure, you will notice a definite, soft "gristling" sound. When the knife sounds as though it were being pushed over wet bone, that part of the hide is completely grained. The grain usually has a darkish tinge, while the main pelt underneath is quite white. In graining, as in fleshing, always work away from the neck (where the going is toughest) and toward the tail.

An experienced worker like Prior can flesh and grain a hide in an hour. Beginners will not finish within three hours. If the grain simply refuses to scrape off, put the hide back in the tub, add more ashes, and let it soak for another day or two.

Softening. The hard work is over when the hide is grained. Hang it up where it can dry, and start cooking half of a buck brain. (The same amount of calf or beef brains will also answer perfectly.) Put the brains into a quart of water and let simmer for an hour, or until they can be mashed into a thin soup. Then add half a teacupful of any animal grease (not mineral), and if the grease is rancid, so much the better. When the hide is nearly dry, but before it gets stiff, spread it out on a clean place and rub the mixture of brains and grease into the flesh side. Then roll the hide into a ball and put it away on a shelf for a few days.

THE MIXTURE of brains and grease draws glue from the raw pelt and makes the hide soft and pliable. A strong solution of yellow laundry soap has the same effect—but the hide must be soaked in it for four days. Neat's-foot oil is another softening agent, and can be substituted for the brains and grease mixture.

In case you use the soapsuds method, you must grease the hide after the four days of soaking. Then wring out, as described hereafter; give it four more days rolled up in this greased condition; unroll, wash, wring again, and frame. The brains mixture such as the Indians used, however, is fastest and makes the buckskin both soft and strong.

Wringing out. When the softening is finished get ready to wring out the hide. Nail one of the wringing poles horizontally between two trees, waist high. Wash the hide for a few moments in strong soapsuds; then, with the tub under the middle of the pole, fish the slippery hide out of the water and wrap it around the pole.

Begin with the neck, end up with the tail, and wrap so loosely that it goes around only three times. Now take one edge of the wrapped hide and start rolling all three thicknesses toward the center of the pole, just as you would roll up your shirt sleeve—or rather just as you would if you were wearing three shirts. Roll only halfway. Then shift to the opposite edge and roll it too toward the center—until at last the two big rolls meet.

Two slippery, whitish, clammy "doughnuts" of skin now ring the stationary pole. Force your other wringing pole half its length through this double ring, and twist this free pole, tourniquet fashion, as much as you can—about two or three turns. Unwind, and you will have a damp, bluish-gray loop about a foot in diameter. Now stick the free pole back in this ring, in a new place, and twist it in the opposite direction. You may even give it a third wringing. Use plenty of strength but remember that it is possible to tear the skin. This wringing should take only a few minutes, and saves hours of finger-breaking pulling by hand sometimes recommended by those who have not made much buckskin.

Now unroll the loop and stretch the hide out on a blanket. Take firm hold of the center with both hands, and pull your right hand away from your left until it finally slips off the edge. Go over the whole hide this way, and the skin will take on the feel and appearance of damp chamois. It should now be white, porous, and clean, ready for framing.

Framing. Make a square frame of boards or poles a foot or so wider and longer than the hide itself. Then punch holes along the edge of the skin at intervals of about 4 in., and lace the hide tightly to the frame. You must have seen pictures of an Indian camp with a hide so framed—a squaw on her heels in front of it. Lean the framed hide in the sun or near a fire. Make a hardwood paddle, 2 ft. long and with a blade the size of a hairbrush. When the hide begins to feel "boardy," place the tip of the paddle blade against it and, using both hands, rub it forcibly down the length of the hide. The paddle will leave a wake of soft, white buckskin; and may you be as thrilled as I was when I did my first pelt. In sunshine or before a fire, ten minutes of this will leave you with a dry and completely soft buckskin. Cut the buckskin from the frame, leaving on the lacing and the narrow, unworked edge of boardy skin.

Smoking. In a hole about 2 ft. deep, build a fire. When you have a good bed of live coals, sprinkle on several handfuls of green oak chips. Then, with your buckskin sewn into a cone, place it over the resulting smudge to smoke. Peg down the bottom of your cone but leave one flap loose so that you can keep an eye on the pit and see that the chips do not burst into flame. (Flame would scorch the hide and take the strength out of it.) Smoke both sides, though it may take a good part of a day. When you have the shade of buff you want, fold the buckskin and lay it away for three or four days, so the color will set. When you are all through you will have a piece of tough, velvety, and silent buckskin—real Indian buckskin that will dry soft even after a soaking in the rain.

Popular Mechanics
Sept., 1902

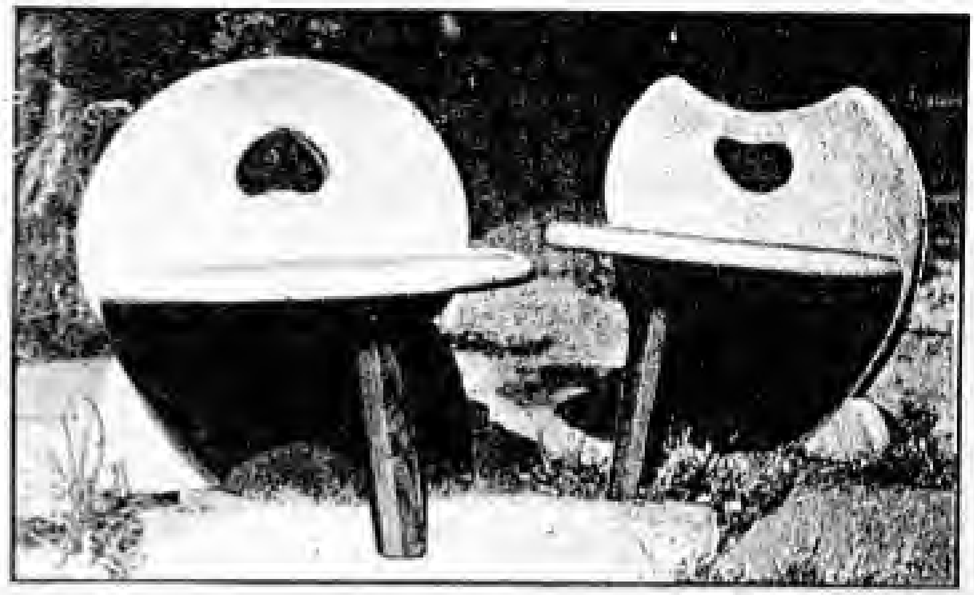
MAKE FLOUR FROM DRIED FISH.

Hot biscuit and fresh rolls made of fish flour may soon be familiar articles of food on our tables. The idea started in Norway where the people catch more fish than they know what to do with, and V. E. Nelson, United States Consul at Bergen, thinks the custom should be adopted in the United States. He says:

"A new and profitable branch of industry might be established in America by utilizing fish in this way. The flour is made by means of an invention which quickly dries and pulverizes the flesh of fresh fish. The fish flour, the resulting product, is easy to transport from one place to another and has great nutritive value.

CHILD'S CHAIR NEEDS ONLY THREE PIECES

Unique little seats designed especially for children's use in the garden

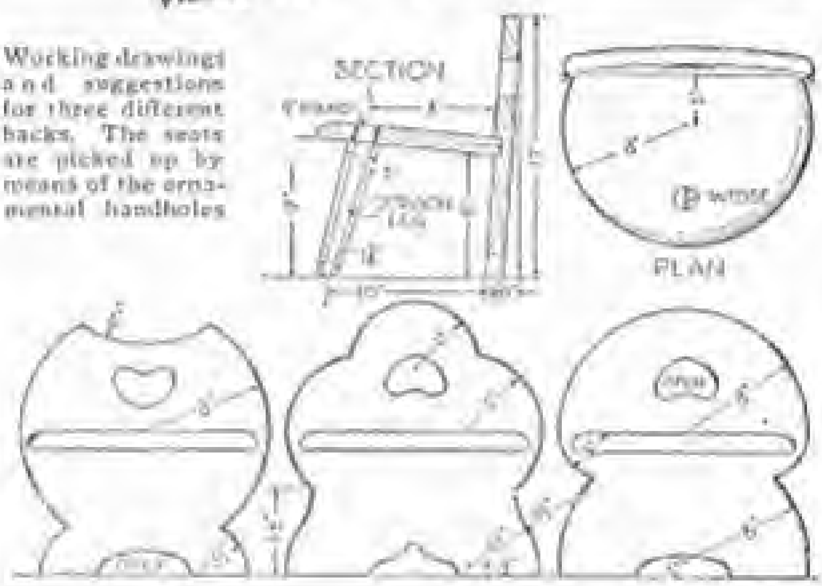


REAL usefulness is combined with economy in these ingenious stools. They were designed for children, but from the way in which they are appropriated by grown-ups at every opportunity—well, possession counts nine points in the law!

The materials required are few: For each stool allow one piece 16 in. wide by 17 in. long for the back, and one piece 12 in. wide by 16 in. long for the seat; these should be 1⅛ in. thick. Also obtain a 12-in. length of wood 2 in. square for a leg, and three 2½-in. screws for attaching the seat and back. If wide stock is not available, put two pieces together with waterproof glue and corrugated fasteners.

The essential tools are a compass saw, an expansion bit or large auger, knife, chisel, wood file, and a light plane. A compass is handy for laying out the work, but a makeshift—even a nail and a piece of string—can be made to answer the purpose.

Three different designs for backs are shown, but all have the same quaint, squat proportions. There is nothing in constructing the chairs to tax the ability of even an amateur. Making the legs will probably require the most time. First lay out the octagons at the top and bottom, making allowance for the taper. After the leg has been shaped, cut a round tenon on the upper end, making it fit the 1½-in. hole bored in the seat. With only a knife, a wood file, sandpaper, and patience, this tenon can be shaped to fit almost perfectly. Make this joint tight, but do not force it enough to split the seat. Secure the leg by driving in a thin wedge as shown in the plan view. To prevent splitting, locate the wedge so that it is across the grain of the seat. Of course, if a lathe is available, turned legs may be substituted for the ones shown.



Working drawings and suggestions for three different backs. The seats are picked up by means of the ornamental handholes

A groove about ½-in. deep is chiseled in the back to take the straight edge of the seat. Shape the groove at the ends to fit the bull-nosed edge of the seat neatly. Fasten them together with three 2½-in. screws. Good glue, of course, helps to make strong joints.

Any easily worked wood may be used. The stools shown in the photograph were made of white pine, and the legs of redwood. As they were intended mainly for outdoor use, they were given two coats of enamel (bright yellow), and the legs were finished in their natural color with two coats of boiled linseed oil. For indoor use, as fireside stools, leave the wood natural, using half oil and half turpentine. If you wish, give them an antiqued appearance by rubbing in a touch of burnt umber or other brown pigment here and there.—JAMES THOMAS.

ALGAE RESEARCH

robert lawlor

A New Food for a New City

The merits of fresh water algae as a source for human protein food are numerous. Some species of algae such as Spirulina contain as much as 60% high quality protein. Another two varieties, Chlorella and Scenedesmus contain 40 to 60% and also 22% unsaturated lipids. As for vitamins, Chlorella cells contain: Vitamin C, provitamin A, riboflavin, pyridoxin, niacin, pentothenic acid, vitamin B_{12}, biotin, choline, vitamin K, lipoic acid, inositol and p-aminobenzoic acid. Green tissue of plants in general are rich in various minerals and Chlorella is no exception as it contains in order of quantities: phosphorus, potassium, magnesium, sulphur, iron, calcium, manganese, copper, zinc, and cobalt. These three algaes have been selected out of perhaps thousands of varieties tested over the past twenty years in various international research projects. This selection is based on the hardiness, rapidity of cell growth and the exceptionally high nutrient value of these cells. Chlorella and Scenedesmus have remarkable adaptation properties and are found existing over almost all the areas of the earth where conditions permit the growth of green vegetation. Within each species there are subvarieties; some varieties of Chlorella grow better at different pH values of the water

and others at various temperatures.*1 For instance we are growing a variety which is best adapted for growth in water at a standing temperature of 39 to 40 degrees Centigrade, while in a 1959 Anarctic expedition, strains of Chlorella were detected in fresh waters of those regions. Spirulina is now generally considered the best variety for cultivation, but our experience has shown that in the climate conditions here in South India, Chlorella is easier to maintain. In our attempts at growing Spirulina we found that after a few weeks an indigenous Chlorella species had entered our tank and rapidly outgrew and replaced the original strain of spirulina which we had planted. It would be advisable to consult with a local university biology department and determine which species and variety is best suited for growth in your region.

These years of world algae research give some interesting data comparing the productivity of this primitive single cell plant organism with conventional food crops.

PROTEIN PRODUCTION PER ACRE PER YEAR IN POUNDS

CHLORELLA	14,000
GRASS	600
PEANUTS	420
BEANS	370
PEAS	353
WHEAT	269
RYE	260
OATS	232
BARLEY	224
MILK	90
MEAT	54

Assuming that the yield of Chlorella is 13 metric tons per acre per year, and that the algal material contains 50% protein.

Experiments in the Tokagawn Institute in Japan evidenced that 13-18 metric tons dry weight per acre per year can be obtained. In another project in the U. S., a yield of 40 tons dry weight per acre per year was indicated. By multiplying the yields from experimental tanks per cubic meter of water, the amount of algae produced indicates that on an average one acre could provide all the necessary protein, vitamins and minerals of 300-400 people. These statistics may be optimistic or misleading for it is yet unproven that these same rates of growth can be maintained in expanded large scale production. In our work, with a circular tank 21 feet in diameter and 24 inches in depth we are averaging between 17 and 20 grams per day per cubic meter, which positively verifies these projected yield expectancies.

The French Petroleum Institute discovered African natives in Chad harvesting a species of Spirulina from a lake and preparing it as a sauce to be eaten with millet. This led to their large experiment in a lake in Mexico whose water contained similar natural constituents, and the climatic conditions also compared with those of Chad. By innoculating this lake with spirulina and developing the cultivation facilities they are now harvesting one metric ton dry weight of algae per day. We have been unable to investigate this work as the research material is published in French, but for those interested the information can be obtained by writing Dr. Gabriele de Alba, Sillivan 51, Cuidad Mexico, Mexico 4 D.F. **The use of natural bodies of fresh water for cultivation** opens many new dimensions in this field.

The exceptionally high photosynthetic capacity and rapidity of cellular division account for the superior productivity of algae. Each cell contains large amounts of the green pigments essential to photosynthetic growth.

Each cell divides into either 4, 8, or 16 new cells and every new cell is capable of photosynthesis and further division. This geometric divisional increase occurs every 12 hours. Each cell is about 3 to 8 microns in diameter and the population is freely suspended in water. For growth, only simple inorganic salts dissolved in water plus carbon dioxide and an assimilable nitrogen and the sun are required. On an average only 0.1 to 0.5 percent of the sun's radiations is fixed as organic compounds by our present food crops in the temperate climate zones; and of the crop plants, we use as food usually only 30 to 50 percent and discard the rest (stalks, stems, etc.). Algae, in contrast, fixes 2.5 to 3.5% of solar radiation into organic matter and 100% of the plant is edible.

The "value" of the protein in algae is rated at 95% which means that all the essential amino acids are present in sufficient and proportional amounts, while the value of the protein in many of the most commonly utilized land plants is only 55 to 75%.

Algae, as a Food.

We wanted to see how these comparable growth advantages could be used to effectively alter dietary patterns in relationship to our communities actual efforts towards a self-sufficient food economy. Only carbohydrates in the form of whole grains and small amounts of nuts and/or beans are necessary to round out and balance a diet which includes 25 or 30 grams dry weight of algae per day. Here in this tropical, semi-arid inland monsoon climate of South India several ancient millets, raggi and kambu, plus moong beans, sesame seeds, cashew nuts and peanuts grow well even in "hardship" soil during the rainy season, with very simple natural, ancient agricultural methods. We limited our selection to these indiginous foods plus the addition of algae. With sprouting, soaking, solar cooking, raw foods and fermenting we have been able to use these few highly nutritious foods in a variety of forms: soup, breads, nut-butters, noodles, porridge, cutlets, bisquits, salads, etc.*2

This diet composed of local seeds plus algae proved to be half the expense and over twice as nourishing as the standard lacto-vegetarian rice diet which our community generally consumes.

In attempting to expand some theories on this information: It is well known that grains produce the highest yeilds of balanced food per acre of most vegetal crops. Corn averages about 2.4 dry weight tons per acre; rice 1.4; wheat 1.6. In speculation about the widespread use of a grain-algae diet and the amount of land required to feed one person, we will assume a daily consumption of two pounds of grains, including some nuts and beans. This would require 1/3 to 1/2 acre of land per person plus 1/300 acre for the algae. Compare this to the 15 or sometimes 20 acres of land per person required to produce and process the standard American diet of meat, fish, eggs, milk, sugar, cheese, pastries, white bread, vegetables, fruits, alcohol, coffee, tea, drugs, and medicine.

The following two tables demonstrate the food values of the algae-seed diet:

If we look into the future towards a united planetary society, a goal which has now become imperative for the survival of our race, we might percieve that the present "underdeveloped" tropical countries such as India and many in South Africa and South America could through algae production become the providers of protein for the entire world as the plentitude of sun and constant warmth make algae production relatively easy and inexpensive. In temperate climates, algae production would require highly technical industrial plants, the construction of which has been estimated at 45 million dollars for a plant facility which could produce 50 metric tons per day.

In our present small scale endeavor we are harvesting continually throughout the year, except during the heavy rains of November and December, which make the open air drying difficult and the growth rate slow. It may be helpful to try to point out some of the differences one would experience in growing algae there in the United States. In South India we have enormous sunshine, sometimes six months of continuous cloudless sun-filled skies. This weather from the point of view of an algae grower is a distinct advantage. On the other hand, we have no accessibility to electric power and other mechanical and technical facilities are greatly limited. So in general, a grower in the United States would look to mechanical means of stepping up production to compensate for the reduction and seasonal nature of sunshine. These devices might include CO_2 bubbling with a solar compressor, since availability of CO_2 is the next most important factor in developing the growth of algae. A mixture of air and 5% CO_2 has proven to accelerate growth 6 to 7 times. Also important are stirring or agitating devices which keep the algae cells in suspension and thereby maintain even exposure to light and increase the photosynthetic level in the tank. Solar heating etc., could be developed so as to extend the growing season of an open basin through late fall or early winter. Algae strains adapted to colder water temperatures could be used as the seasons indicate. In the Japanese experiment cultivation was maintained yearlong, although the yields were small enough to make it an undesirable practice. But the 13 metric ton figure was established on an <u>average</u> yield, including the poor growing winter months.

One pessimistic note must be added here. The fact that algae is so efficient in converting air, water, and sunlight into organic vegetal compounds means also that if there are pollutants such as mercury, sulphur or lead in the water or air, their pollutants will be concentrated in the algae cell at very dangerous levels. So environmental contamination must be <u>carefully</u> appraised before cultivation is undertaken. For this reason the West German government abandoned their European site and are now continuing the algae production work in India.

We are not technically trained people and this article is meant to be more an introduction than instruc-

TABLE 1

	PROTEIN	FAT	MINERALS	FIBRE	CARBOHYDRATES	CALORIES	PROTEIN VALUE
Wheat 100 g.	11.8	1.5	1.5	1.2	71.2	346	66%
Sesame 75 g.	15.0	41.6	3.0	0.8	14.4	496	70%
Cashew 70 g.	14.8	32.9	1.7	0.9	15.6	417	72%
Mung Beans 70 g.	17.5	0.6	2.2	1.0	42.0	253	55%
Raggi 100 g.	7.3	1.3	2.7	3.6	72.0	328	89%
Kambu 60 g.	7.1	3.0	1.4	0.8	41.0	216	83%
Chlorella 25 g.	11.8	6.3	0.6	0.2	6.3	75	95%
TOTAL	85.3	87.2			262.5	2131	

TABLE 2

	VITAMIN A*	B_1	B_2	NIACIN	C	CHOLINE	B_6	FOLIC ACID
Wheat 100 g.	108	0.45	0.12	5.0	10.0	206		
Sesame 75 g.		0.73	0.26	4.0	0.8			
Cashew 70 g.	70	0.44	0.14	1.8				
Mung Beans 70 g.		1.04	0.32	3.6	12.0	600		
Raggi 100 g.	70	0.43	0.10	1.1				
Kambu 60 g.	132	0.20	0.10	1.9				
Chlorella 25 g.	125,000	0.10	0.07	4.4	80.0		0.18	1.3
TOTAL	125,380	3.39	1.1	21.8	102.8	806	0.18	1.3
MDR	5,000	1.3	1.7	17.0	60.0			0.4

*Vitamin A is measured in International Units (IU) and the remaining vitamins are measured in milligrams.

tion on algae growing.

PUTTING TOGETHER OUR SYSTEM

Our experiment is more on the level of a home garden. We are operating now with a 20,000 litre open cement basin with a wind-driven stirring device and three auxillairy 4,000 litre tanks for settling. We begin by adding to the tank of 20,000 litres fresh water 40 litres of cow urine per thousand litres of water, or about 800 litres of urine which has been gathered from dairy cows and stored in 75 litre plastic drums, plus an equal amount of sea water and an equal amount of algae culture. We developed our culture from a test tube slant of pure Chlorella which we obtained from the biology department of the University of Delhi. The algae first grows in flasks, then it is put into a 10 litre basin for 10 days, then it is dumped into a 200 litre tank. In each expansion of the culture medium the same ratio of nutrients is maintained, which is 40 ml. of urine and 40 ml. of sea water per litre of fresh water. Sea water can be approximated by mixing 26 mg. of pure dehydrate sea salt to every one litre of water. With this initial innoculation and fertilization the tank is allowed to grow and in 8 to 10 days the entire body of water should be bright green. At this point an addition of 35 litres of fresh cow urine per day is begun. Two to three weeks after the innoculation harvesting can begin. We gather the urine from a dairy. Two or three cows produce more than enough urine to meet the requirement. As cows have a tendency to urinate just before milking it is easy to catch it in a bucket and deliver it to the tank without it touching the ground. Because these are milking cows they are examined frequently and one can be assured of their health. The urine-sea water mixture is far less costly than a chemically fed tank and in our preliminary tests algae grew two to three times more rapidly in this mixture than in any of the synthetic mixtures tested.

To some the use of cow urine may seem extreme. In an early experiment with a small closed community we gathered the human urine, sterilized it and used this for our urea. There is normally sufficient natural urea contained in a person's urine to give back in the form of algae 60% of his daily protein requirement.

There are other possibilities for a natural liquid nitrogen source apart from urine, such as the waste from vegetable oil extraction mills. The pressing of peanut, sesame, cottonseed or other oil seeds leaves a cake residue which is often very high in nitrogen. The cakes can be soaked overnight and the liquid portion applied to the tank instead of or in addition to urine. Also malt waste from beer breweries might be used.

The following table shows a comparison of the mineral and nitrogen contents of sea water and urine, both individually and into the "natural medium," as compared with those in the recommended chemical medium for Chlorella culture:

TABLE 3

	Sea water mg/100ml	Urine mg/100ml	Modified Fogg's Medium constituent	mg/l	Natural Medium mg/l
Na+	1100	600			510
Cl-	1984	600			775
K+	39.1	150	various	58-85	57
Ca++	44.1	15	0-0.1 g/l $CaCl_2$	0-36	18
Mg++	134	10	0.2-0.3 g/l Mg SO_4	160-240	43
SO_4	276	150	0.2-0.3 g/l Mg SO_4	160-240	130
HCO_3	12				4
PO_4	traces	150	0.2-0.3 g/l NH_2PO_4	140-210	45
urea		2000	0.6 g/l urea	600	600
NH_4+		47			14
Fe++	traces	traces	5 mg/l Fe $SO_4 \cdot 7H_2O$	1.0	traces

We made the mistake of excavating and constructing our tank in the ground using 8 centimeters of concrete which was then plastered with smooth cement containing a water-proofing compound. Because our water level is below the ground we must pump the algae water from the 20,000 litre tank into the 3,000 litre auxilliary settling tanks. The depth of the growing tank is only 10 to 15 inches to allow for sunlight penetration. The depth of the three settling tanks is one metre and we enclose them with a screen lid which blocks out the sun. When the algae is denied sufficient sun it ceases to grow and settles to the bottom of the medium in about 24 hours. After this settling out we pump the upper level of water from the settling tank back into the large growing tank and in the bottom three inches of the settling tank there will remain a thick mixture of algae. This mixture we then place into 75 litre plastic drums for a second settling process of 24 hours.

The operation of pumping could have been avoided if we had constructed the tank up on a raised platform and with a tap arrangement merely drew the algae water out of the growing tank directly into plastic drums.

In each transfer of the algae medium from tank to tank and from tank to drum and drum to bucket we pass the medium through screens to remove bugs and foreign matter. The drums have a closeable top so that when the algae remains in them overnight the lack of air causes rapid settling, so that the upper level of water may be poured off to leave 6 inches of frosty thick algae in the bottom. Then this algae may be washed with fresh water by simple decantation.

The thick washed algae is laid out in the sun for drying on polyethelene sheets for 8 to 12 hours. We built wood frame drying bins 3 feet by 6 feet by one foot which holds the plastic in place and prevents the dust from blowing in and the dried algae from blowing out. All these processes can be worked into a sequence which requires only one or two hours of work per day.

By the use of these three simple hand methods in place of mechanical centrifuging

for settling and drying contrivances for dehydration combined use of a free organic fertilizer in place of chemicals, the cost of production is greatly reduced, making algae growing accessable to small, non-technical levels. After the initial installation cost, the running expenses are negligible. We have provided algae on a regular basis for as many as 18 people for a limited period and for 8 to 10 people regularly throughout the year

One interesting side experiment was done last spring using algae as a fertilizer. One-half-acre of rice paddy land was irrigated with two inches of standing water one month prior to the planting date and was sprayed with 300 litres of Chlorella culture from our tank. Also, 30 litres of cow urine was sprayed at the same time to provide some nitrogen for the algae. After about 10 days a rich green film of algae covered the entire field. This was allowed to grow for the remainder of the month and the two inches of standing water was maintained during this period. The algae grew thick and green and alive on the top. Underneath, near the soil, it continuously decomposed, thereby giving nitrogen to the soil. The rice seedlings were transplanted and the cultivation continued in a normal manner. The algae continued to grow simultaneously with the rice. Adjacent to this field another ½ acre was sown using commercial urea, phosphate, potash and cow dung, and next to this a control area was planted using no fertilizer at all. The results of this experiment were very encouraging as the algae fertilized field yielded 30% more rice than the commercially fertilized plot and over 60% more than the field using no fertilization. The local government agricultural department has now taken up continuing research in this method of fertilization.

FOOD, ENERGY, AND CONSCIOUSNESS

Briefly, one can see that algae could become a food for soil, for plants, for animals and for humans. This recalls a passage in the Upainshad: "When man has mastered the food of foods, the green stuff of the universe, he shall become great in progeny, great in knowledge, great in radiance, and great in glory."

Those of us now using algae as food feel that we are moving in a right direction by eliminating from our diet foods produced through expensive and wasteful conventional methods, such as dairy, meat and soft vegetable farming and substituting a low bulk, highly concentrated natural food which is rich in both nutritional content and in more subtle vital energy qualities.

It is true that nearly a quarter of a century ago the elaborate research and development of algae cultivation in the U. S. and Japan was theoretically successful but failed on a practical basis due to the factor of taste. That period of history was the time in which the movement of petroleum and plastic industrialization was launching into its peak decades of materialistic affluence. But now, 25 years later, with the collapse of the system and the years ahead promising starvation circumstances unparalled in history, there will no doubt be less resistance to dietary changes and modifications. Also the natural food movement in the U. S. and Europe has brought to the awareness of many young people the destruction that the modern standard American or 'Western' diet has done to the 'public health of the race.' There will be in this generation a willingness to let go of these injurious food habits and preferences, and young people will begin to eat more for the health of the body than for the sensations of the tongue and nerves.

In the fermented dehydrated form which we have worked out so far, the addition of algae only moderately changes the taste of bread, soups, etc. and is in no way unpleasant. Its taste is somewhat like some of the varieties of Japanese sea vegetables only without salt. Our extremely nutritious algae-nut-butter mixture, for example, is undeniably delicious.

Through other experiments with an electroencephalograph recording device wired to plants, we have become more appreciative of the "life-energy" fields which envelop plants and fresh foods. Also we are involved with the concept that these energy fields are transmittors of the various life qualities determined by the content, form and function of the plant, in a contextual relationship within itself and with the entire environment. Perhaps this vibrational aspect of food could be imparted to the cellular consciousness of the person who eats it. Algae, being a cellular form dating back probably three billion years, is considered to be the primal cellular form from which the entire 300,000 other vegetal forms have evolved. In addition, algae is the cell most sensitive and responsive to solar light and energy. These two qualifications alone are of great importance to those interested in the aspects of consciousness as represented in foods and in the role food could play in our future evolution.

Auroville is a process in which we attempt to integrate material, work, and experiments into a total concept of the meaning and goals of our existence. The research for a "new" food is in itself a small step, but it has its basis in an expansive context of both physical and spiritual values.

In a certain sense, we are attempting to examine the correspondences between the way food is used for energy on the individual level and the way fuel is used on the social level. From this perspective, we consider the human body as the common primary environment shared by the entire world community, viewing the present world environment and energy crisis as an extension of a metabolic crisis within the body of the human race. The pollution, waste and destruction of the biosphere, the meaningless materialism of our time have their roots and origin in the way our present limited ego-consciousness conceives and utilizes its own bodily environment. More simply stated, our technology is an exteriorization of our "physical consciousness." As an example, we commonly conceive of our physical motive energies as being derived from the breakdown and burning of foods in our digestive tract. At the same time we deny other more subtle and perhaps more powerful means through which the body may receive energies. We ignore investigation of other physiological possibilities by which the body's metabolic

Above: Algae in leaf-like flakes, immediately after drying.

Below: The final product: the dried algae is ground into flour.

system can be developed to conduct and utilize the unlimited universal energies which surround us. Therefore in our technology as in our physiology our production and utilization of energies is dominated exclusively by the principle of internal combustion.

Entering into the laboratory of the body with a higher consciousness we can begin the work of the reconceptualization of our own physical processes. Perhaps we may discover that the heightening and harmonization of the mind, the life and the deeper levels of our being, particularly as they relate to this physical instrument, can be extended into a universal harmony of man with the body of the earth and the cosmos.

FOOTNOTES

1* The pH factor is very important in maintaining an algae culture. In photosynthesis the nitrogen is broken down into an ammonia compound which is highly alkaline and this raises the pH of the tank. Most algae grow in an alkaline medium but some at higher rates than others (Spirulina 9.5, Chlorella 7.5). It may be in some cases necessary to occasionally adjust the pH by the addition of small amounts of commercial grade HCl. It is interesting that most pathogenic bacteria require a moderately acidic medium in which to grow so this specific alkalinity of the tank allows some protection against contamination by protozoa, bacteria and other undesirable algae strains.

We recommend keeping a check on the contamination factor in the tank by observing under the microscope a sample taken each week. The presence of bacteria, protozoa and other microorganisms is much less than would develop normally in an open tank with a medium of this type without the algae factor, which produces the alkalinity to maintain consistantly a relatively safe level in the tank. When the alkalinity drops the bacterial contamination proportionately increases.

The temperature at which the algae is dried is an added factor in contamination control and should, if possible, reach 120 degrees F. Cooking the algae in various forms is a further safety measure.

We have no doubt that our standard of safety in tank would not be acceptable to laboratory codes of hygiene and sterility which are applied by staunch advocates of the microbial theory of medicene and disease, but nevertheless, many of us have used the algae daily in our diet for over one year without a single case of ill effect.

2* Although the nutrients themselves are easily digestible in Chlorella it is difficult for the body to assimilate due to the presence of a cellulose capsule around each cell. In our experiments with the finely ground Chlorella with the flour of two types of locally grown millets (Raggi and Kambu), add water and then ferment the mixture in an earthen pot one day in the sun. At night we boil this mixture and boil it again the following morning. We take this mixture at noon in the form of a thin porridge. By using this method of preparation, which was used in Egypt 5,000 years ago and which is used by the Tamil people today, we are fairly sure that the cellulose capsule is broken down and the algae is then making a positive contribution towards our nutrition.

MORE ON ALGAE

MIKE HOHMAN

I found Robert Lawlor's article in ASE #16 very interesting. Utilizing primary production as an energy source is

only practical. I would like to add a few things however. In addition to nutrient properties previously mentioned, Chlorella vulgaris has been shown to produce a substance, chlorellin, which has an appreciable antibacterial activity against Staphyloccus aureus. It has also been shown that in "excessively low" concentrations it stimulates Chlorella pyrenidosa produces antibacterials by photooxidation of unsaturated fatty acids.

Green algae contain chlorophylls a and b, which means they utilize light with wavelengths in the red and violet portion of the spectrum. They store food as a true starch. Better than half of the absorbed light energy ends up locked within glucose molecules as potential chemical energy.

It will be necessary to know the measurements of the algal cells in order to distinguish species, etc. The unit of measurement is the micron, designated μ, it is one one-thousandth of a millimeter or 1/25,000 in. A linear scale on a glass disc (ocular micrometer) which can be placed on the interior shelf (diaphram) of a microscope eye piece (ocular) can be calibrated in microns with the aid of a stage micrometer. The ocular micrometer can then be used to obtain measurements of algae. A Whipple micrometer, used in plankton counting, can also be used. Most algae can be distinguished with magnifications between 100 x and 500 x but 1000x is recommended in order to determine some of the blue-green which seem to be the troublemakers. If samples are not examined withing 2-3 hours they should be preserved with formalin. Add 40ml formalin 37 - 42% aqueous solution of formaldehyde) per liter of sample.

I think it is very important, and <u>should be emphasized</u>, that there are many records of acute and often fatal poisoning of livestock where the animals had been drinking from ponds containing dense algal blooms. The blue-green alge are the usual culprits and they grow very profusely. The symptoms associated with blue-green poisoning are prostration and convulsions followed by death. In my limited studies, I have found lethal doses to vary from 0.005 ml-2 ml in two minutes time. Pretty strong stuff! One toxin survived 1 hour of autoclaving at 15 lbs. and was not neutralized by polyvalent botulinus antitoxin. It is for this reason that anyone thinking of using algae as a foodstuff should definitely have access to a good microscope and identification key. This identification should be carried out on a continual basis--perferrably daily in "bloom" conditions.

Three prominently dangerous blue-greens are : Anabaena L., Aphanizomenon, and Microcystis. All are fresh water varieties and have several similar species. Several others have been found poisonous but these were mentioned most often. The following are excellent information sources:

<u>Standard Methods for the Examination of Water and Wastewater</u>. 13th edition '71. Available from Am. Public Health Assoc., 1015 18 St. NW, Washington DC 20036. Over 800 pages detailing the accepted laboratory procedures for water examination and treatment, bacterial analyses, algae and pollution problems in general. The "professionals" standby. Also contains color plates of algae. Costs $22.50 hardbound, but should be in most large libraries. Excellent.

<u>Algae in Water Supplies</u>. Public Health Service Pub.#657, by C. Mervin Palmer. Available from Pub. Health Service, Washington DC. An illustrated manual on identification and significance of algae in water supplies. Cost $1.75 a few years ago.

<u>Fundamentals of Ecology</u>. 3rd edition '71. By Eugene P. Odum. Excellent background material. Covers energy flow, biogeochemical cycles, and evolution of the ecosystem.

I hope this information will be of help to someone. Whatever ones reasons for turning to algae production, it must be remembered that nothing comes free--not even in nature. Best wishes.

Mike Hohmann
3544 Emerson Ave S.
Mpls, MN 55408

Popular Science August, 1937

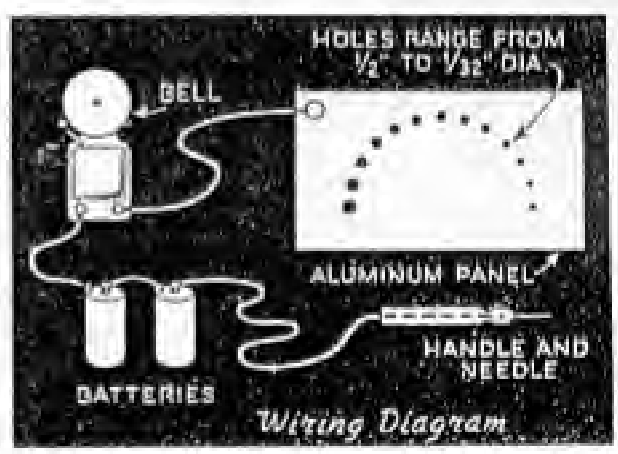
A Tester for Steadiness of Hand

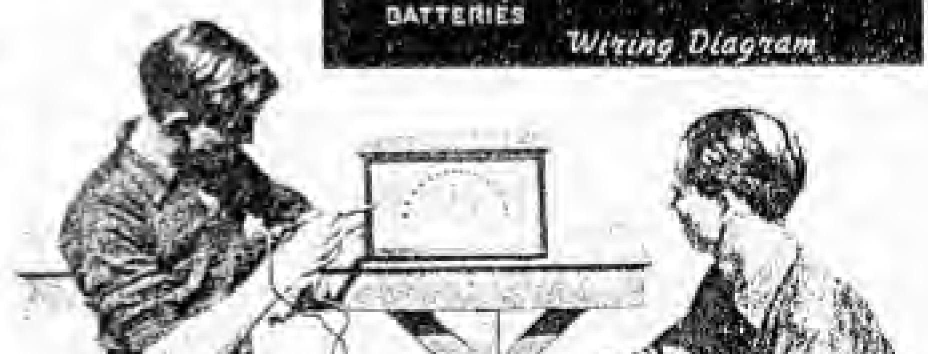
A "NERVE TESTER" like that illustrated will furnish much entertainment at parties, and it is an excellent science project for high-school pupils to make.

The aluminum panel which forms the front of the box has a series of holes varying uniformly in diameter from ½ to 1/32 in. The individual who is undergoing the test is given a needle set in a handle and asked to insert the point in each hole in succession and withdraw it without touching the side of the hole and without using any support for his hand. If he does touch the metal, an electric bell rings. The object is to see how small a hole he can reach before this happens.

The box and panel may be any convenient size. The doorbell and battery are placed in the box and are connected as shown in the diagram. It is well to provide a binding post on the side of the box for connecting the flexible wire leading to the needle.

The model illustrated was made as a science project by Paul Bevan and Rufus Issleib, eleventh-year pupils in the Phineas Banning High School, Wilmington, Calif. It has been used in connection with psychology tests.—M. H. COMPTON.





The object is to insert a needle point into each hole, beginning with the largest. If the needle touches the panel, a bell rings

BARBARA M. WATT

Try your hand *at working clay: lamp made by pinched pottery method*

For beginners . . . pinch pottery

SUNSET
FEBRUARY 1967

Making a pottery form by pinching together lumps of clay is a good way to acquaint yourself with the potter's medium. Ceramist Sarah Eiehorn of Boulder Creek, California, designed this lamp as a beginner's project. It holds two different-sized candles.

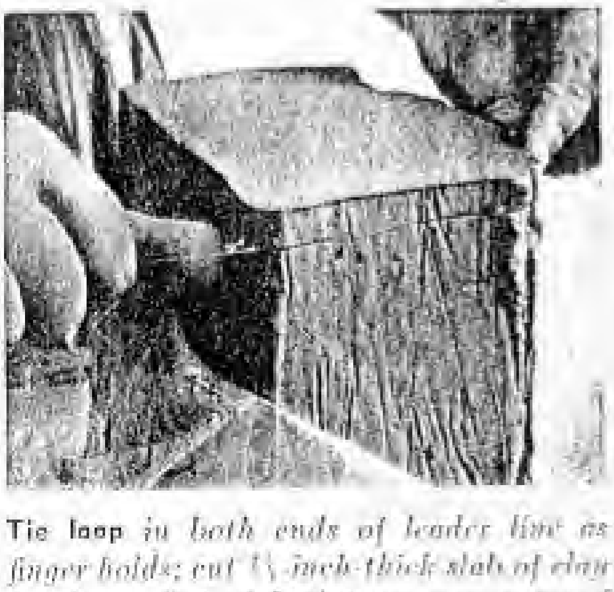
You can purchase clay in 25-pound plastic bags ready for use. Buy sculptural rather than wheel clay. A 25-pound bag of medium-meshed, red-burning clay (the type used to make this lamp) sells for about $3. Clays vary in their firing temperatures, so if you plan to have the lamp fired commercially, better discuss the type of clay to be used with the kiln operator before purchasing. Check your telephone directory under "Ceramics" for a shop that provides this service.

Make *½-inch-diameter clay coils; attach to base to form 1 and 1½-inch-diameter candle holders. Then build up the sides*

Add lumps *of clay in rows. Keep walls ⅓ inch thick and as evenly curved as possible. Paddle with spoon to smooth sides*

In addition to the clay, you will need a few simple tools: a 2-foot length of nylon fishing leader line for cutting the clay (loop the ends over the middle finger of each hand or over two pencils to get a good grip); a paring knife; a wooden spoon; a cutting tool made by binding a bobby pin to the end of a dowel with wire (see tool on the table in the lower right-hand picture, page 130); two fruit jar rings, one from a large-mouthed Mason jar and one from a standard jar; and a short length of metal tubing. Not strictly necessary, but useful, is a small lazy Susan of the kind available in many housewares departments. Its use allows you to rotate the lamp to bring the side you're working on nearest you.

Clay shrinks about 12 per cent on drying; make the lamp proportionately large. The one shown stands about 10 inches high.



Tie loop *in both ends of leader line as finger holds; cut ½-inch-thick slab of clay for base. Pat slab flat on paper towel*

Form outline *of base by placing jar lids on clay, cutting around them with a knife. Transfer base on paper to lazy Susan*

Keep the lamp growing vertically in as even a slope as possible; don't let the damp clay spread. When you add each lump of clay, work it into the adjoining edges with your fingertips and turn the top edge in a little to keep it going right. Add a couple of rows of clay before smoothing them together inside. But don't attempt to make the lamp too smooth and neat; the marks of your fingertips will give it a primitive, handmade quality. From time to time, take the wooden spoon and paddle the clay gently inside and out, supporting it with your other hand. The paddling helps to weld the clay lumps together and gives the lamp subtlety of shape.

If you have to stop work on the lamp before you've completed it, put wet paper towels over the rim, then cover the lamp with a plastic bag. Clay will quickly clog ordinary household plumbing, so be sure to wash your hands in a pail of water and then empty the pail outside.

Finish lamp *with conical top. Let it dry overnight. Cut flame shapes with knife; cut circles with short metal tubing length*

When the shape is finished, take your homemade cutting tool and cut away any irregularities around the base of the lamp, rotating it on the lazy Susan as you work. Set the lamp aside to dry, uncovered, overnight or until it reaches the cheese-hard stage, before cutting the design.

When you cut the design, keep bridges between the elements fairly thick so the clay won't crack in drying. Make one flame shape large enough and low enough that you can fit the candles through it into their holders. If the lamp slumps as you cut the holes, paddle it very gently to bring it back into shape.

Set the lamp aside to dry thoroughly. Once it is dry, you can sand the edges before you have it fired. Later, you can glaze it if you like.

Mrs. Eichorn fired the lamp shown only once and left it, unglazed, in its natural warm terra cotta color. It makes a handsome lamp to be used in the garden, not so much for its light as for the fanciful patterns it casts on walls and foliage.

Choosing, using a screwdriver

SUNSET MARCH 1965

The lowly screwdriver is probably the most frequently used tool a home owner possesses. And he probably botches more jobs with this simple tool than with any other. Here are some reasons.

First, the screwdriver is really too handy for its own good. It's likely to be the first thing you grab when you need to scrape dried paint off a concrete floor, dig out a weed, or clean a mortar joint in masonry. A little abuse of this kind, and your screwdriver is blunted and dull. Next time it is put to its proper purpose, it may very well slip on a tight screw—burring the screw head and gouging the work (or possibly your hand).

Or a bad fit may lead to trouble. If the driver is too small or too large for the slot of the screw, it can easily burr the screw head or gouge the work. For this reason you should try to keep at least three sizes around the house or workshop. This involves no big expense; a 40-cent, wood-handled screwdriver is as satisfactory for most work as a $2 product.

Again, there are many situations where an ordinary driver will not work. You need a Phillips screwdriver to handle a Phillips screw. And you need at least a small selection of the other types of drivers shown on these pages to handle all the screws and small bolts you encounter at home these days.

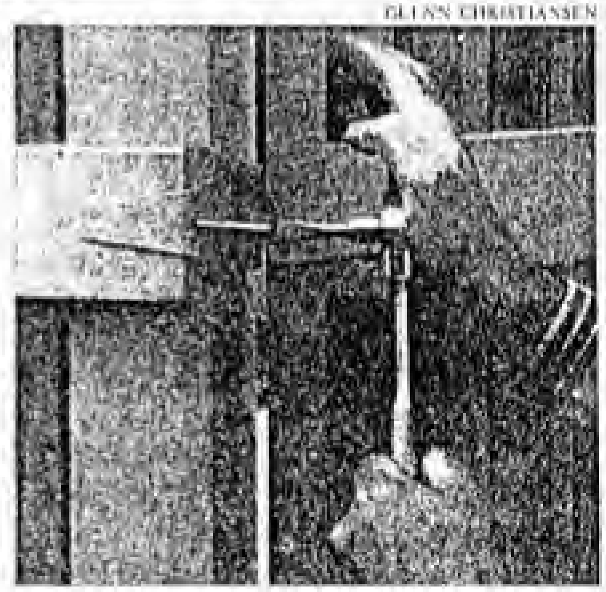
Many jobs are bungled by screwdrivers that are simply no good. If drivers are so worn and blunted that their tempered tips are gone, or if they have been overheated, no amount of sharpening will repair them. And you may find that some cheap screwdrivers, or some accessory drivers that came as "gifts" with your car or outboard motor, are of soft steel with little temper.

Still another source of grief may be that

Blunted *and paint-coated, a tired screwdriver usually does more harm than good. It burrs the screw slot, gouges the work*

your screwdriver is adequate but you are not installing the screws correctly. In all but the very softest wood, you should drill lead holes for screws. In hardwood, the holes should be approximately the diameter of the screw's core (the maximum diameter of the threaded part, measured from thread bottom to thread bottom). In softwood, the holes can be about two-thirds the core diameter, and smaller still

GLENN CHRISTIANSEN



For large screws, *a driver with more leverage is handy. Here a screwdriver socket tip is used with a socket ratchet handle*

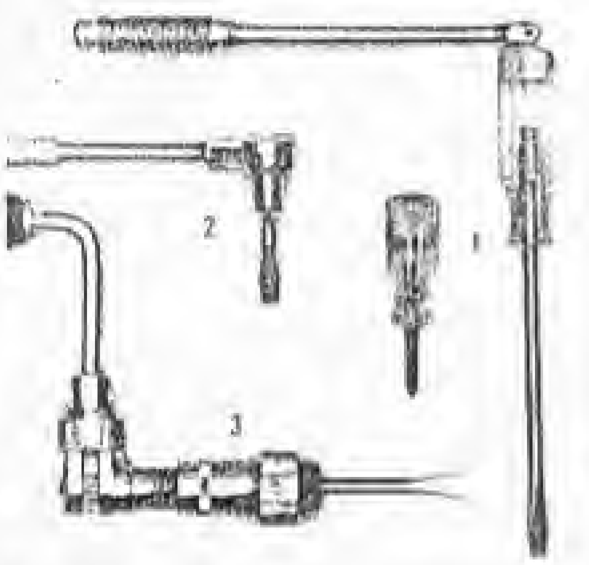
in the end grain of the wood. When using long screws, you should also drill larger shank-sized holes in the wood to the depth of the screw's shank (the unthreaded portion), or use a screw pilot bit that cuts both hole sizes at once.

If a good screwdriver requires undue muscle and tends to burr the slot with the screw only partially in, you should remove and discard that screw, and enlarge the lead hole for another. With brass screws (especially long ones going into hardwood), it is a good idea to drive in and remove a similar steel screw first, to form threads for the softer screw.

TIPS FOR THE SCREWDRIVER BUYER

When you buy a large, ordinary screwdriver, choose one with a square shank. Then, when you have a stubborn screw

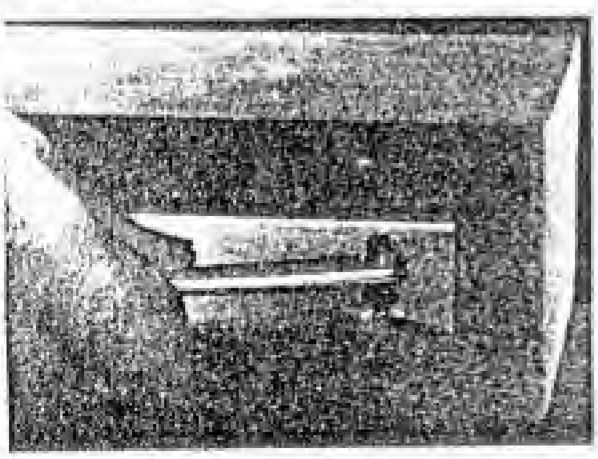
Handy *ordinary screwdrivers for the home: (1) and (2) long and short-shanked, for general use; (3) jeweler's, with five tips; (4) heavy-duty, with square shank; (5) spiral-ratchet, with tips and drill bits*



Leverage *drivers: (1) ordinary screwdriver and a Phillips, both with sockets in handles to fit a socket wrench; (2) driver tip for a socket set, as in photograph below; (3) driver tip for a carpenter's brace*

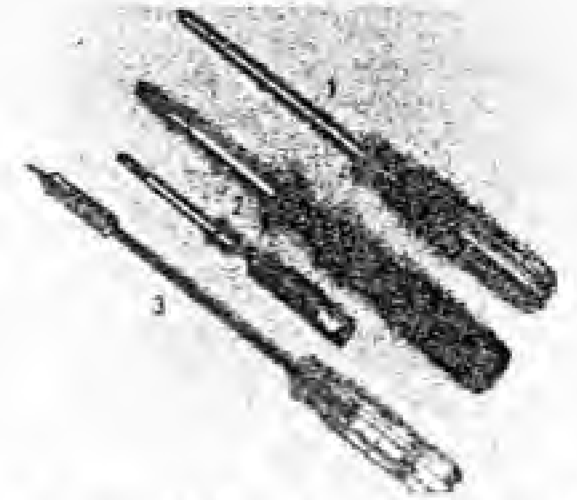
to seat or loosen, you can easily use a wrench on the square shank and apply extra leverage.

You will find that a long screwdriver lets



In tight quarters *like this, you need an offset screwdriver. This one has a reversible ratchet and both a large and small tip*

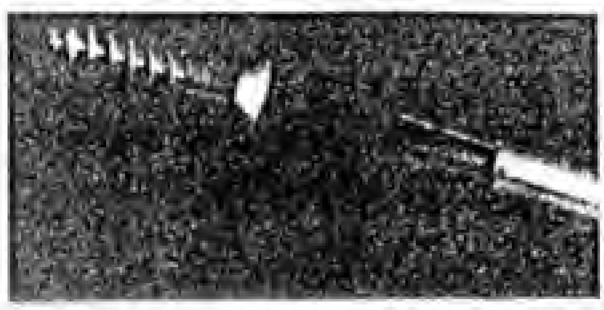
you apply more power than a shorter one with a tip of the same size, and the long one is less likely to be tilted in the screw



Good screw-holding *drivers: (1) magnetized Phillips tip; (2) large and small two-piece wedge tips; (3) sliding spring clip*

slot. It's best to save the stubby one for spots where you're cramped for space.

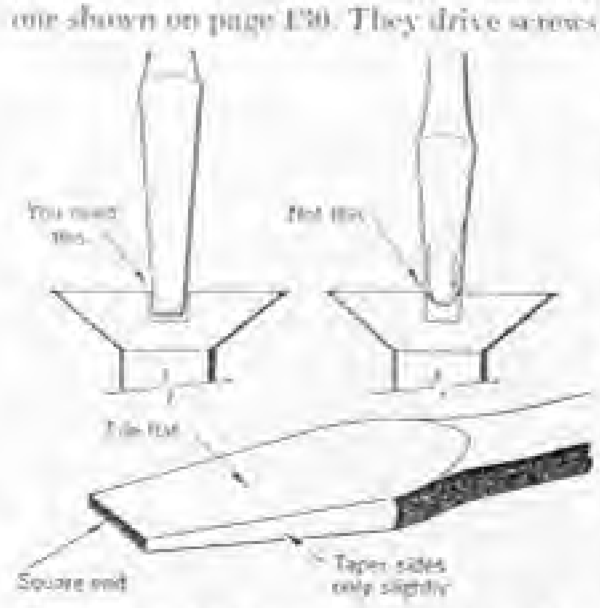
If you need to install a number of large screws, a screwdriver bit in a carpenter's brace works easily and rapidly. To drive



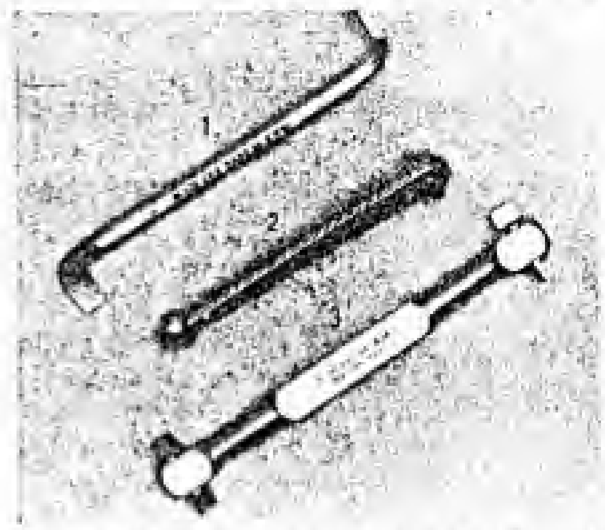
For hard-to-reach *places. Two-piece tip of this driver wedges in the screw's slot, holds the screw, and seldom slips in use*

a great number of screws, as in boat building, a power drill equipped with a speed-reducer screwdriver attachment works even better. (This $10 to $15 accessory is rather cumbersome for most household uses, however.)

You may see carpenters using spiral ratchet "speed" drivers longer than the one shown on page 130. They drive screws



Sharpen *a dull screwdriver like this. Square the end first, then grind or file sides of the tip to a long gentle taper*



Three offset *screwdrivers: (1) double-end; (2) ratchet with tip on each side; (3) four-tip, each same size but at a different angle*

rapidly, but cost $8 and up, and slip easily unless you have had practice.

A magnetized screwdriver of the Phillips type holds those screws well; but slotted screws sometimes slip out of a magnetized driver of the ordinary type. Wedge-type drivers hold slotted screws well under all situations.

OTHER HANDY HINTS

To hold a screw on a plain screwdriver, tape screw and driver together with a small piece of masking tape, and remove the tape when the screw is partially driven.

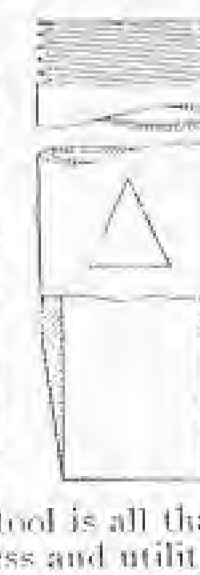
Rubbing a bit of soap or wax on a screw makes it easier to drive it home.

To remove a stubborn screw, heat it with the tip of a soldering iron. Let the screw cool before using the driver.

Remember that your screwdrivers need to be kept sharp. An ordinary file will sharpen most of them easily and smoothly. On a power grinder, use the finest wheel, and avoid overheating the driver's tip.

Popular Mechanics — 1915

Pipe Used as a Leather Punch



The sketch shows how a very cheap and serviceable leather punch can be made of an old pipe nipple. Pieces of pipe of almost any size can be found around a shop, and it is, therefore, usually possible to quickly make a punch of the required size. The cutter end can be ground very thin to prevent an overcut, while a small slot cut a little above it will allow the removal of the leather slugs. For its purpose, this homemade tool is all that can be desired in cheapness and utility.

Hoses *on old fire truck are lengths of ⅜-inch doweling. Boiler is chunk of 1⅜-inch stair rail. Front wheel wells were cut by repeated passes into blade of table saw*

SUNSET

Scrap blocks for toy making Dec. 1967

Scrap blocks of wood and various drawer pulls are the principal ingredients of these wheeled toys. Working with a table or band saw and using some imagination, you can turn out similar vehicles in short order for a son, a nephew, or a neighborhood boy.

One way to start is to borrow a library book on old-time vehicles. Use the pictures as a rough guide, altering and embellishing as your materials allow. Guess at the sizes; cut and recut as needed. Glue all pieces firmly together so that they'll take abuse.

To make axles and wheels, force ⅜-inch doweling into holes drilled into the back of drawer pulls. (For the flat-bed truck pictured below, we first glued a small wood knob onto each larger, concave knob). The axles turn inside screw eyes affixed to the bottom of the vehicles, or inside holes drilled through a body piece.

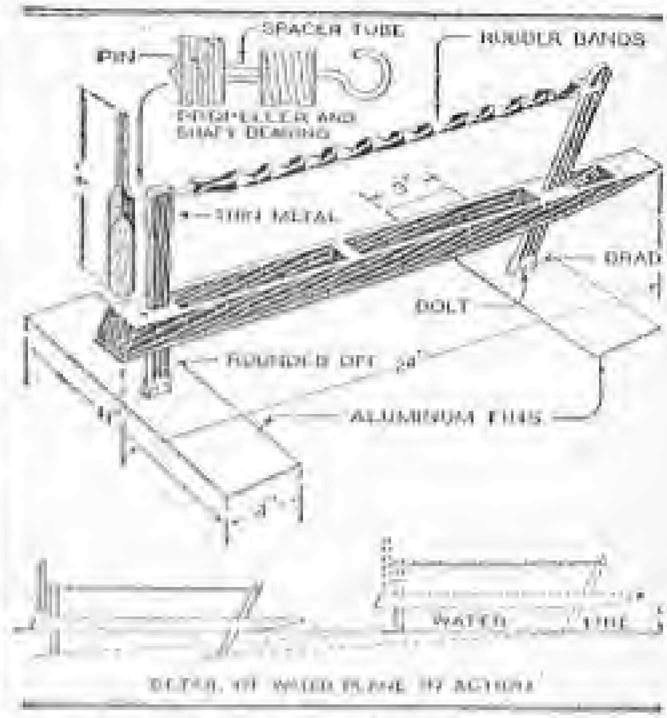
Paint the toys—or, for a quicker and equally attractive job, varnish them; the differences in kind of wood and in wood grain give a pleasing range of tones.

Old-time locomotive *takes shape. Quarter rounds, 1 by 2 form boiler. Cut wood post finial in two for realistic smokestack*

Turn-of-century *truck made mostly from scraps of 1 by 5 pine, 1 by 2 and 2 by 3 redwood. Steering wheel is drawer pull*

A Toy Water Plane
pular Mechanic — 1925

The toy water plane shown in the drawing is something of a novelty in the way of model water craft, as the hull only



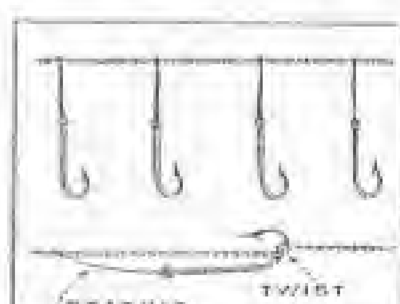
A Toy Water Plane That Rides on the Surface of the Water When Its Propeller is Revolving

rests upon the water when the propeller is not revolving. In traveling at full speed, the hull leaves the water quickly and rides with the fins on the surface of the water, as illustrated.

The sides and bottom of the hull are built up from strips of pine, about ⅛ in. thick, blocks being used to space the sides the proper distance apart and for the attachment of the wooden supports for the propelling mechanism and fins. The sheet-aluminum planes, or fins, are mounted as shown, so that each is tilted at the same angle. The plane is driven by a model-airplane propeller, which, for a 24-in. water plane, should be about 7 in. long, and the power is derived from a motor made of a number of rubber bands linked together.

Popular Mechanics — 1925
Taking Up a Trot-Line

When taking up a trot-line, the usual result is a bad tangle of hooks and line, which is difficult to avoid unless the staging is removed entirely. The drawing shows a method that entirely overcomes the trouble. Each



staging is pulled tightly along the line, and the cord is given a single twist around the hook. After all the hooks have been treated in this manner, it is a simple matter to wind up the whole line without danger of tangling; when the line is set again, all the hooks will be in place and there will be no snarls.

 THE SURVIVOR Vol. 6

SUNSET DECEMBER 1967

How to make marbled candles, ice-mold candles, waffle candles

When candles come from your own kitchen, the choices of shape, color, pattern, and surface are yours.

We're going to show you three techniques by which you can make quite different candles: a bottle-molded candle of various colored waxes, a perforated ice candle, and a waffled candle. For all three, you should melt the candle wax over hot water (as in a double boiler) so it won't burn.

Pour these in a jar

Big, wide jars as molds show off the marbling of these candles. Remove the label, and be sure the jar is clean and dry inside.

Attach a small fishing weight to a length of metal core wicking, and wrap the other end around a pencil.

To ensure that the wick will hang straight when you tilt the jar for pouring, fix it in the center bottom of the jar with a lump of child's modeling clay. Also use clay to stick the pencil to the rim. Prop the jar at an angle, pour in some wax, and let it harden. Repeat this process, propping the bottle at a different angle, and pouring in wax of a different shade. Keep doing this until the bottle is full.

When you break off the mold there will be lots of shattered glass, so wear gloves, put the candle inside a paper bag, and hold the bag over a box. Tap the mold with a hammer, first around the bottom, then at the top and sides. Remove the sack and pull off as much glass as possible, then put the sack on again and tap gently until all the glass falls away. Wipe off tiny splinters.

Over ice cubes

The alternating of small ice cubes and hot wax gives these candles their unique appearance. The wax solidifies around the cubes, and then the ice melts, leaving open spaces through each candle. As it burns down inside, a lacy effect results.

Use a simple cardboard mold. Cut the top off and clean and oil it. For the wick use a taper, cut so that it is about ¾ inch higher than the mold. (If you use a taper of contrasting color, its drippings will be visible through the interstices of the candle.) Stand the taper in the center of the mold and pour about ½ inch of wax into the bottom as a base to support it. Fill your ice cube tray with only ½ inch of water, so the cubes won't be large.

Gently drop a layer of cubes into the mold, then add wax until the cubes are almost but not quite covered. Repeat until the mold is filled. Build a mound of ice that reaches the top of the projecting taper, then cover it with wax. The mound will gradually sink to give you a flat-topped candle. Let wax harden overnight. Carefully tear away the mold.

Weight wick, *suspend from pencil*

Tilt *bottle differently each pour*

Break bottle *inside bag, over box*

DARROW M. WATT

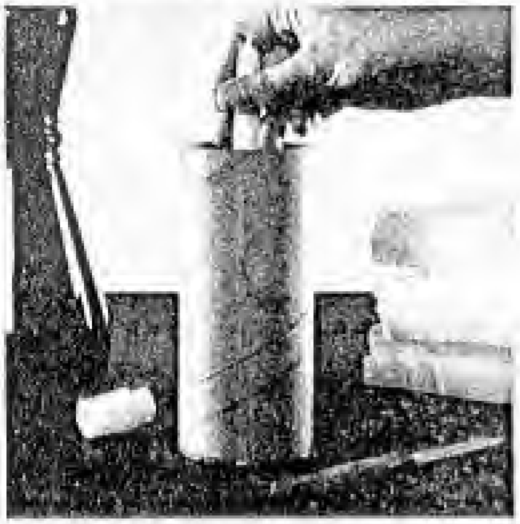
Wide-mouthed *coffee jars lend shapes and fluted bottoms to marbled candles. Shades of blue, green, white suggest ocean waves*

GEORGE WOO

Interplay *of hot wax and ice cubes makes caves and channels all through these candles. Taper burns steadily at center*

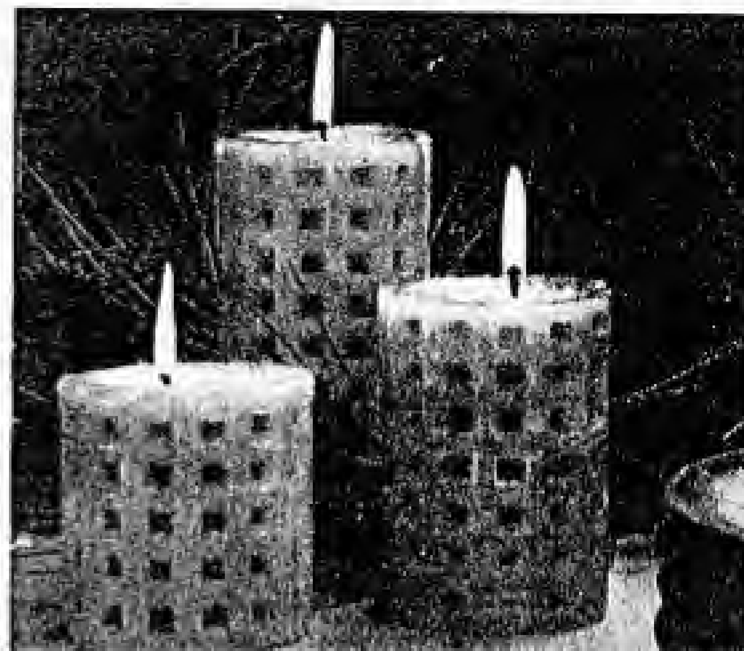
Waffle iron candles

You make wax waffles for the outside of these textured candles in the removable grids of your waffle iron. Don't worry; the process will do these grids no harm. Scrape off any bits of carbon that might stick to the wax, and moisten the grids



Candle *for wick stands in center*

Bend *water-warmed waffle as needed*

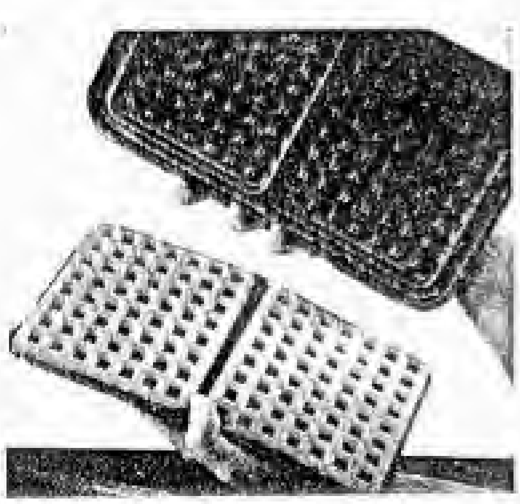


Fresh from waffle iron, *paraffin sides of candles have two-toned indented pattern. You make them in your removable grids*

Wax over ice *sinks, makes flat top*

DARROW M. WATT

Fill *the grids in one or two pours*



Loosen *with knife, pop out waffle*

grid. Use the knife to trim the edges.

Clean an empty round Parmesan cheese or household cleanser container and anoint with salad oil. Warm them slightly in the oven (no more than 200°) so wax won't adhere to the tops of the squares on the first pour (see next paragraph).

Household paraffin works best for the waffles, as it holds together well when warm. For a two-toned waffle, make two pours of paraffin, each of a different color. Pour wax of one color into the waffle grids, leaving the protruding squares exposed. Cool a bit, and pour wax of the second color to cover the squares and fill the grid. Put into the freezer for 10 minutes, then loosen gently around the edges with a knife and pop the wax waffle out of the with salad oil. Soften the waffles by leaving them for a few minutes in a shallow pan of quite warm, but not hot, water. Bend the waffle to fit around the inside of the cardboard mold. You can piece the waffles if necessary, for warm paraffin slices cleanly with a knife.

For the wick, you make use of a slim candle. Cut it to the height that your fat candle will be. With a little softened wax, seal the edges of the waffles together, pour a ½-inch base of wax, and stand up the taper in it. Let cool.

Pour glow candle wax (available at hobby shops) in the center. It is translucent, and will let light come through the waffle pattern as the candle burns down. Let cool, then peel off the mold.

Popular Science April, 1937

Leaf Designs Decorate Easter Eggs

Small, wet leaves are wrapped around the eggs and tied, and the eggs then dyed brown by boiling them in water with onion skins

IF YOU want something different in the way of Easter-egg decorations this year, try this novel variation of the old trick used in the days before egg dyes were common, when the eggs were sometimes boiled with onion skins to give them a distinctive brown color.

Obtain some small leaves from house plants, weeds, blades of grass, or anything that happens to be available. Wash them, wrap them while wet around the eggs, and fasten them with fine cotton or silk thread. Boil the eggs in plain water along with a handful of onion skins. When the wrappings are removed after the eggs have been boiled, each egg will bear the decorative white imprints of the leaves on a rich brown-colored background. The thread must be very fine or lines may show.—A. G. HOFAMMANN.

Sunset June, 1969

Candle-making at the beach

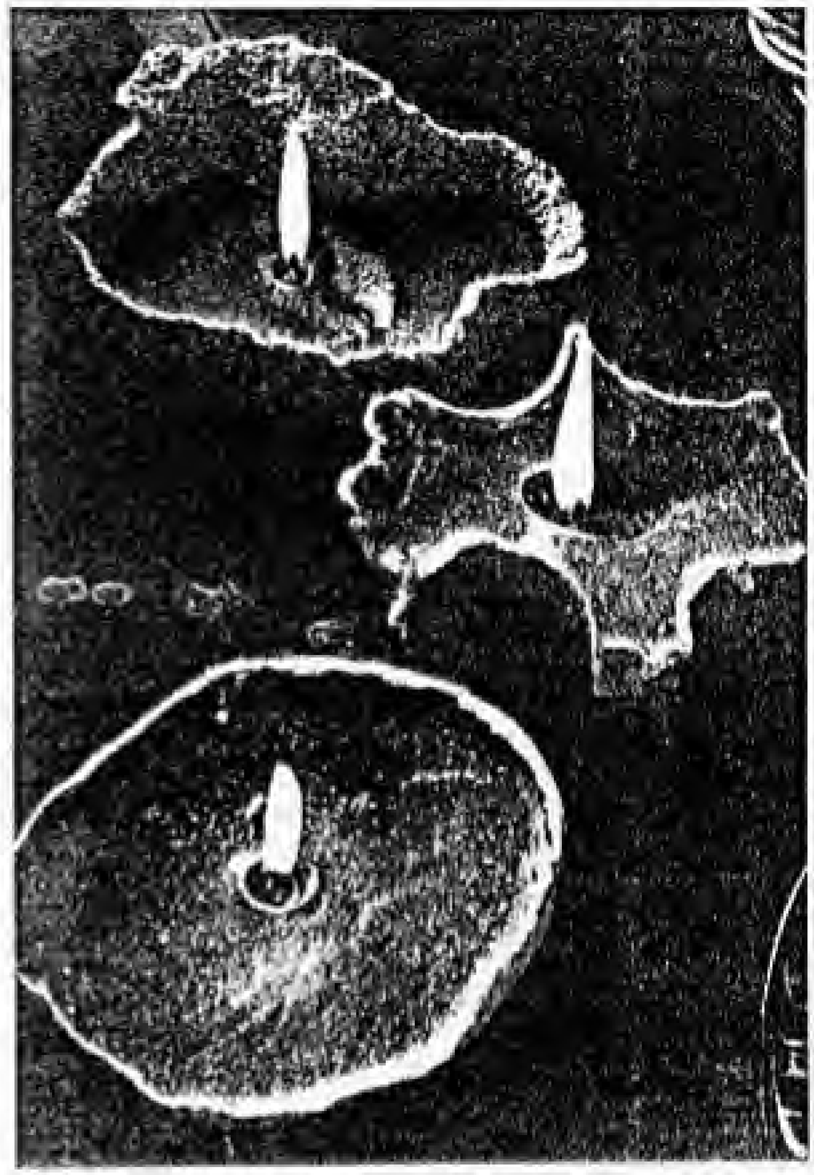
With these candles, poured into sand molds at the beach, the fun you have making them is more important than the end results.

You should bring a camping stove, an old pan and a coffee can for melting the wax, paraffin, crayons for color, wicking, something to stir the wax, a pot holder, and perhaps a few utensils to create the sand molds—a custard cup, a small tin can, or a spoon. Unless the sand at the beach is quite fine, it won't hold very detailed shapes, but the most interesting ones anyway are those you make with your hands.

If you heat the wax to at least 250°, the sand and wax will make a better bond. The can must be put directly over the flame; the temperature can be measured on an old candy thermometer. The candle at the top and the one at the bottom of the photograph were done this way, but the center candle was made with wax melted over a water bath.

The sand must be quite moist—and you might note that it's best to work on an outgoing tide. Make a depression in the sand for any overflow, and then form your mold in the depression. Set the wick and then pour the hot wax rapidly into the mold. The extremely hot wax sizzles as it's poured in.

Let the candle cool completely, perhaps 2 hours or more, depending on its size; then gently remove. Let it dry thoroughly before brushing off the excess sand.



Gracing *a picnic table, candles cast in beach sand are textured and rough looking*

GLENN CHRISTIANSEN

Melt wax *in can over water-bath on camp stove while everyone is making his mold*

Wrap waxed wick *around wooden dowel; rest over top of mold; pour wax into mold*

After wax *has completely cooled, you can gently lift the candle out of the sand*

How to make scented candles

Sunset Nov. 1967

Making Christmas candles is part of the fun of holiday preparations in many households. This year we propose a way of scenting them with native Western aromatic plants.

In warmer areas, you might scent candles with various species of eucalyptus and citrus. Almost everywhere you can find California laurel (called Oregon myrtle in the Northwest); sagebrush and yerba buena, a member of the mint family. The best of the conifers is the coast redwood, but also very good are Douglas fir, Port Orford cedar, and Western red cedar. Another good choice is the root of the wild ginger.

Not all these additions give off the odors you would expect once they are in the wax. Redwood retains its original scent, and our redwood candles kept their woodsy odor to the last nubbin. But the laurel (or myrtle) candles, which at first had the pungency of the freshly crushed leaf, gradually lost sharpness and after a week or so developed a sweeter, more delicate perfume. Candles scented with Douglas fir smell more like incense than mountain forests.

For your candlemaking you will need wax, wicking, coloring material (children's wax crayons work well), several 1 or 2-pound coffee tins, a collection of molds, some cheesecloth, and whatever aromatic leaves you have growing near you. Hobby shops sometimes carry candlewax and wicking. Be sure to buy both hard and soft wax and mix them half and half. Candles made entirely of soft wax will melt in a warm room and bend out of shape. Those made entirely of hard wax will burn neatly down the center without ever melting at the rim. You can use your old candle ends if the colors will blend nicely. Metal-cored wicking is especially good for large candles, and easy to use because it is rigid.

First melt wax and coloring material in a coffee can placed in a pan of simmering water. (You can judge the color by dipping up some wax in a deep spoon and cooling it.) While the wax is melting, cut the leaves in small pieces and tie loosely into a bag of cheesecloth. For a 2-pound coffee tin three-quarters full, you will need about two handfuls of leaves. Push the leaves below the surface of the wax and let the mixture stand 10 minutes while you prepare molds.

Fancy bottles make beautiful molds if you don't mind breaking them once the wax has hardened. Plastic freezer jars are good molds. So are cartons for cottage cheese, milk, cream, and ice cream. Cardboard tubes from waxed paper or paper towel rolls make good molds if they are well greased and set upright in a thick flour-and-water mixture to seal off the end. You can make a matched set of candles of different heights using these tubes. Glass, because it's so smooth, gives the best outside surface to the candles.

Once the molds are ready to fill, place them on several thicknesses of newspaper in an area where you can leave them for an hour or so to harden. Remove the cheesecloth bag from the wax, and bend the coffee can into an oval for pouring. Be sure you have more wax than you need to fill the molds, for wax shrinks in cooling and you will have to top with more.

Fill the molds and wait until they are just warm and deep depressions have formed in the center before pouring again. (This may take several hours for large candles.) Reheat the wax you have kept aside and put into it a length of wicking about 2 inches longer than the candle. Remove wick, straighten and let cool. Pierce the center of the candle with an ice pick dipped in boiling water. Insert the wick, then fill the depression with wax.

For very long, narrow candles such as those made in paper tubes, you will have to place the wick before pouring. To do this, dip the wick several times until it is very stiff with wax. Then insert the end into stiff flour-and-water paste and center the tube over it. Push the tube down into the paste, then center the wick at the top and attach it to a knitting needle or other narrow, rigid support. Tape the support in place across the top. Once the wick is centered and firmly attached, pour the wax. Allow the candles to cure for a week.

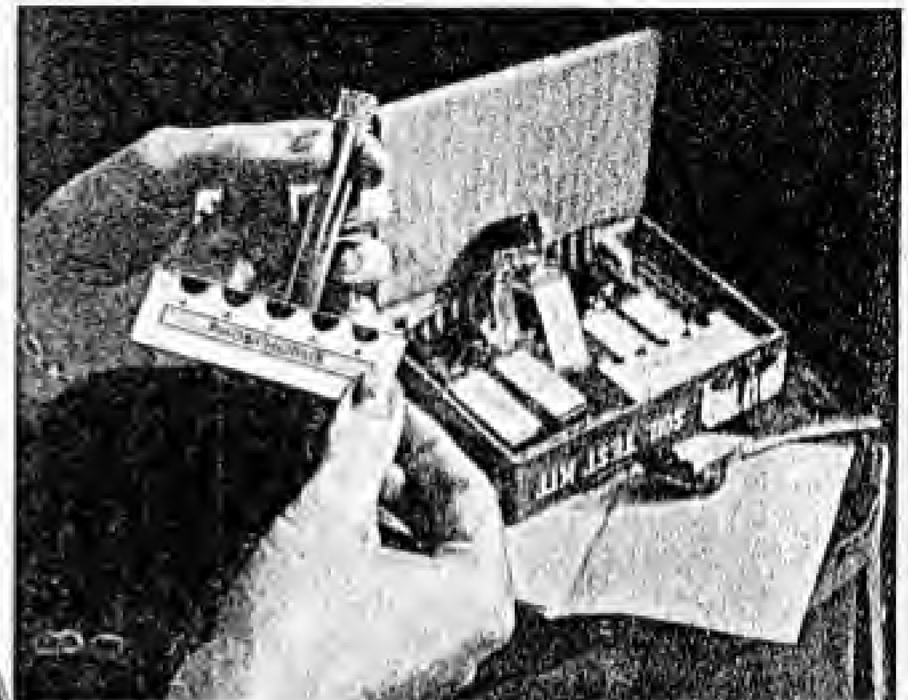
Scented candles *decorated with their own aromatic leaves. From left to right at top: bay, redwood, eucalyptus; center, cedar; at bottom, lemon, Douglas fir, and redwood*

How Good Is Your Garden?

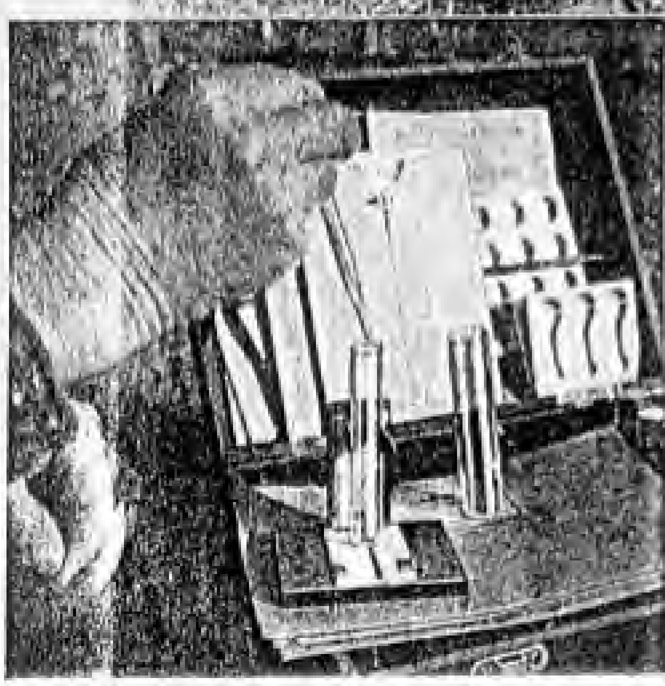
SOIL-TESTING KITS POINT THE WAY TO BETTER YIELDS

By ARTHUR HAWTHORNE CARHART

POPULAR SCIENCE MONTHLY
JULY, 1938



TESTING FOR PHOSPHORUS. With the small soil-analysis outfits, tests are made by shaking soil in prepared solutions and matching the color reactions against transparent color samples. In the photograph at the left, one of the more elaborate kits is in use in the garden



This is how the phosphorus content of the soil is determined with the outfit at top. Reagents are measured in drops, to make it easy for amateurs

WITH faces painted, their bodies almost naked, members of the Snake Clan of the Hopi Indians dance with live rattlesnakes between their teeth to insure good crops. Near little *placitas* that are remnants of Colonial New Spain, plowmen carry the image of a saint with them as they cultivate the soil so that harvests may be bountiful. But the modern gardener, amateur or professional, can look in a test tube to learn the secrets of his soil and know what he must do to make his fields, flower plots, and vegetable beds produce flower, fruit, and foliage. Science has brought the chemical laboratory into every garden.

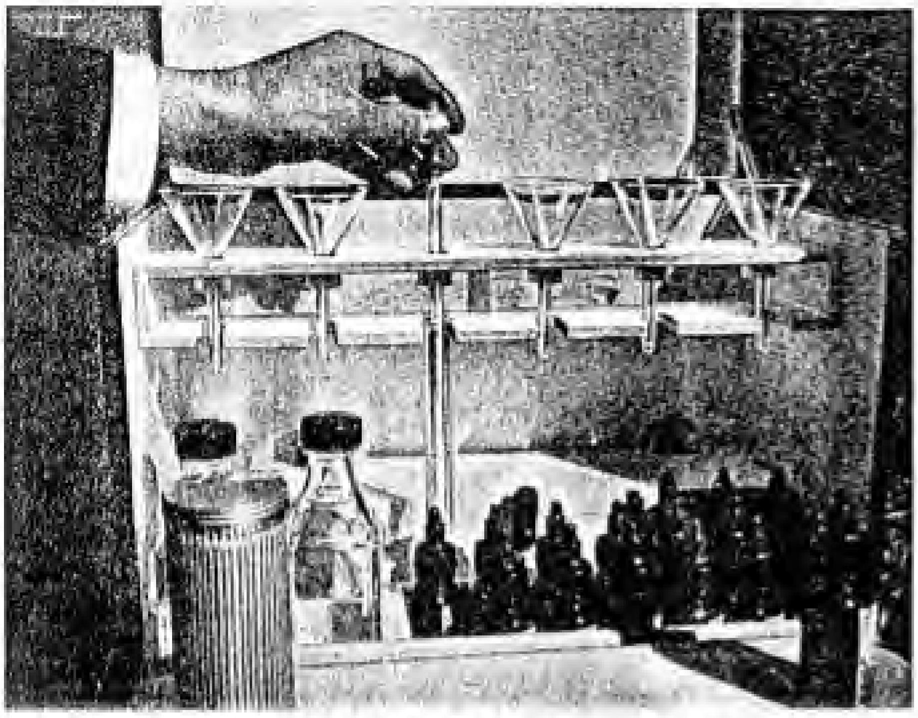
In past years man wrestled blindly with the hidden processes at work in field and garden. A half century ago, few people thought of soil particles as tiny natural laboratories where changes always are taking place. Mineral values of soils were a mystery. The hordes of beneficent or malignant bacteria in cultivated fields were unknown. The farmer or gardener knew the soil was "good" or "poor," and by cut-and-try methods learned to lime, mulch, and fertilize to make land more productive. Often his guesses as to what should be applied to a soil to increase its fertility were wrong. If the crop failed, he changed methods next season. Again he might be wrong. It was a slow, costly business.

Then the chemistry of soils developed in finely equipped laboratories at state experiment stations. A wealth of scientific data concerning crops and their plant-food requirements was gathered. Still, no home owner could hope to set up his own laboratory to test soils in his own back yard. Even if he was technically trained, his pocketbook forbade the purchase of expensive equipment required.

Now it is feasible for every home gardener, farmer, florist, and vegetable grower to know the important facts concerning the chemical content of his tilled ground. A half dozen companies are offering soil-testing kits so simple, so inexpensive, that anyone may check the productive qualities of his garden's earth. The old by-guess-and-by-gosh program of fertilizing soil is as out of fashion as hoop skirts. Appealing to snake gods and saints has been made obsolete by modern science.

The principal chemicals needed in a soil to make it productive are nitrogen, phosphorus, potassium, calcium, magnesium, aluminum, manganese, iron, and sulphur. Of these, the most important are nitrogen, phosphorus, and potassium. Nitrogen is the plant food that produces green growth. If it is too abundantly present the plants may "run to top" without properly developing fruit and flower. Phosphorus and potassium, the other primary plant foods, stimulate fruit, root, and flower growth. In the majority of soils, if these three are present in adequate amounts, there will be sufficient quantities of other mineral foods to make a crop.

On every bag of commercial fertilizer there usually is a series of numbers; for instance, 5-8-7. This number series would mean that the prepared fertilizer contains five percent of nitrogen, eight percent of phosphorous and seven percent of potash (potassium carbonate). The bulk of the material in a prepared



PORTABLE FIELD LABORATORY. Equipped with glass funnels, filter paper, pipettes, and numbered bottles of reagents, this complete kit will determine the amounts of even the less vital nutrient soil elements. At the right, a sample of soil is being sifted and mixed in preparation for testing

fertilizer is generally peat, loam, sand, or other "carrying" medium. The average commercial fertilizer is a sort of estimated gunshot application of nutrient values to the soil. Without knowledge of what already is in the soil, a routine application of such fertilizer may put some chemical into the soil that is present in sufficient quantity, and not supply enough of another plant food to keep a proper balance in nutrient values. A test of the soil that shows the presence or lack of these available plant foods is a positive guide by which the gardener can purchase only those chemicals that should be added to bring the soil into a balance.

Furthermore, if no commercial fertilizer is found to fit the needs of the soil, one may mix his own, buying the separate chemicals that carry the plant foods in available form, and combining them, in a sort of tailor-made fertilizer to exactly suit the individual garden's needs.

Soil tests determine another fundamental fact in relation to growing conditions—whether the earth is acid or alkaline. This is as important as knowing the amount and balance of chemical plant foods in the garden. Different plants require different degrees of acidity or alkalinity. A rhododendron, for example, planted in a soil slightly alkaline, is doomed. Asparagus, however, will die if the soil is *not* alkaline. It is vitally important to know the acid-alkaline qualities of a soil, and this is the first test the home gardener makes with his testing kit.

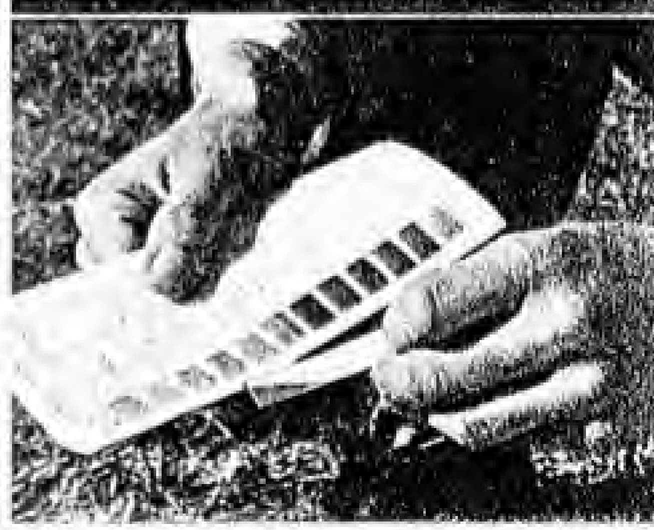
THERE is nothing technical about the soil-testing kits now offered on the market. There are no chemical formulas to remember, no exactly calibrated apparatus to manipulate. Anyone able to read average newspaper English and tell the difference between light blue and dark blue, or light orange and dark, can make the tests.

The simplest kit is so small it can be carried in a coat pocket. It costs two dollars and has sufficient solutions and all equipment necessary to make five complete tests of acidity-alkalinity, nitrogen, phosphorus, and potassium. Anyone who can pour dirt from a teaspoon into a glass tube, and solutions out of a small bottle, can operate it. This is the kit for the average home grounds. While it does not check on manganese, iron, and other nutrients of secondary importance, it does give positive results in testing for the four most important factors.

More elaborate kits range in price from seven or eight dollars to thirty and up. At thirty dollars there is a field kit weighing seventeen pounds, fully equipped, that will determine the amounts of calcium, magnesium, aluminum, manganese, iron, and sulphate sulphur in a soil in addition to the four primary tests.

From the little pocket kit no larger than a surveyor's field book, to this compact and inclusive field laboratory in the larger outfit, every test is marked by extreme simplicity.

Let's run through a test with the pocket kit. You scoop up a sample of dirt with an ordinary teaspoon. It may be a composite sample, a mixture of soil from all over the home grounds, or from some specific spot. One of the four test tubes in the kit is filled one-fourth full of soil. The cork on each tube is enameled a different color so the same tube will be used each time for the same test.



ACID OR ALKALINE? In the simplest of the tests for this important soil property, a reagent is applied to a sample on a prepared test paper and the resulting color is compared with a chart

The solution for the test is poured in on top of the soil until the tube is half full. Then it is shaken thoroughly. At the end of several hours the soil has settled. The solution above the soil is colored. There are four pieces of cardboard in this kit, each with colored tabs of transparent material inset on the edges. If you are testing for phosphorus you pick up the phosphorus

color chart, matching the color of the liquid in the tube with one of the color insets. Each of the five colors on the cardboard is marked by a letter. If, for example, the tint of the liquid matches the color inset designated as "C," reference to the pamphlet with the kit will show that this soil needs a fertilizer that is twenty percent phosphorus. That is the percentage of available phosphorus in "superphosphate" chemical fertilizer. Knowing your deficiency in this plant food, you have the answer as to what must be put on to bring the nutrient values of phosphorus up to a level to insure maximum fruit and flower growth in that soil. It is as simple as that.

Even the largest kit is simple to operate. This tiny field laboratory is equipped with glass funnels, filter paper, pipettes, and numbered bottles of reagents with stoppers that are like medicine droppers. The reagents are added, not by cubic centimeters or other scientific measures, but by drops. All one has to do is count the drops.

IN THIS kit, a master solution is made by placing a teaspoonful of earth in a filter paper in one of the glass funnels and pouring a liquid over it. The filtrate caught in a large test tube serves for every test. To make the nitrogen test, the operator uses a clean pipette to transfer a specified amount of the filtrate to a cup in a porcelain plate. Then four drops of the reagent in the bottle marked "1" is added. It is allowed to stand two minutes, then stirred with a glass rod, and the color appears. All that is necessary to arrive at the available nitrate nitrogen in the soil is to compare that color in the solution with the printed color chart that is part of the kit. A blue-black color in the solution indicates 100 or more pounds of nitrate nitrogen in the top seven inches of an acre of soil. A faint trace of blue indicates as little as two pounds of available nitrate nitrogen in the same volume of topsoil. Tables in the manual give the number of pounds to the acre required by various crops, and it is a simple matter to determine how much nitrate-carrying chemical fertilizer need be added either to the acre or to the 100 square feet of garden soil, to bring that soil up to the proper productive level.

THE availability of chemical nutrients in the soil has a direct relationship to the acidity or alkalinity. Extreme acidity or alkalinity may "lock up" the nutrients. If the soil is alkaline and deficient in nitrogen, and a crop with acid preference is to be grown, ammonium sulphate will add both nitrogen and acidity to the soil. If a crop with alkaline preference is to be placed in the soil, the alkalinity can be retained and only nitrogen added by an application of cyanamide or sodium nitrate. The tests show definitely what should be added in fertilizers to bring a balance between nutrient chemicals and the acid-alkaline reaction. Tables in a handbook give the requirements of almost every common garden, field, and orchard crop, and thus guide the gardener in making up soil deficiencies to give the growing crop the most favorable soil-food balance.

In every case, the only point at which anything is left to the judgment of the soil testing gardener, is in the matching of colors in the solutions with those on the charts.

Anyone interested in amateur chemistry can make tests with his own equipment. (P.S.M., Aug. '37, p. 70). Further information is contained in the Connecticut Experiment Station bulletin, No. 372. This supplies color charts for every test, and gives a full list of the simple laboratory apparatus needed. The bulletin can be secured at a nominal cost.

Just one or two examples will illustrate how valuable these soil tests may be. Potatoes prefer neutral or slightly acid soil. But if the soil is definitely acid, the scab disease that may ruin a crop will not attack potatoes. Therefore, if a grower can be sure that his soil tests below the point of acidity at which scab will attack, he has insurance that his crop will be free of scab. Similarly, eggplant and tobacco must be grown in soils that are sufficiently acid to protect them from disease.

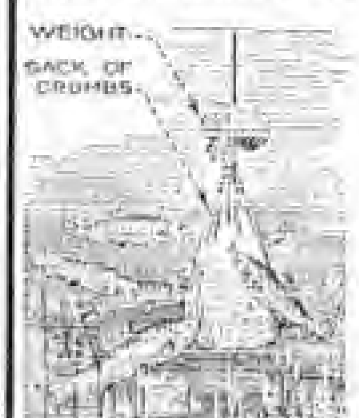
THE soil of gardens, fields, greenhouses, and truck patches is a vast empire in which chemical reactions are constantly working. No two fields contain exactly the same nutrient values, and one end of a flower bed may differ in chemical qualities from the other end. Every growing crop has its preference as to soil. What may be food for one is poison to another. Beets, cauliflower, celery, lettuce, onions, and spinach must have a soil that is alkaline. Blueberries, potatoes, rye, strawberries, sweet potatoes, and melons would not grow well in such soils, but do best in soils that are definitely acid. And each of these has its preferences in the amounts of such plant foods as nitrogen, phosphorus, potash, and manganese.

Thus, the magic of science has opened the way for every grower of plants to unlock the mysteries of his soil. By simple, direct, and positive tests, the gardener of today may know the good qualities of his soils, learn their deficiencies and correct them, and provide the most favorable conditions for the crop he is growing. The little field kits, the pocket and handbag laboratories with their color tests and ease of operation, have opened a door through which anyone may proceed to scientific soil control for growing flowers or crops, insuring better yields and the added pleasure of understanding the secrets of growth.

Crumbs as Lure for Fish

Popular Mechanics — 1925

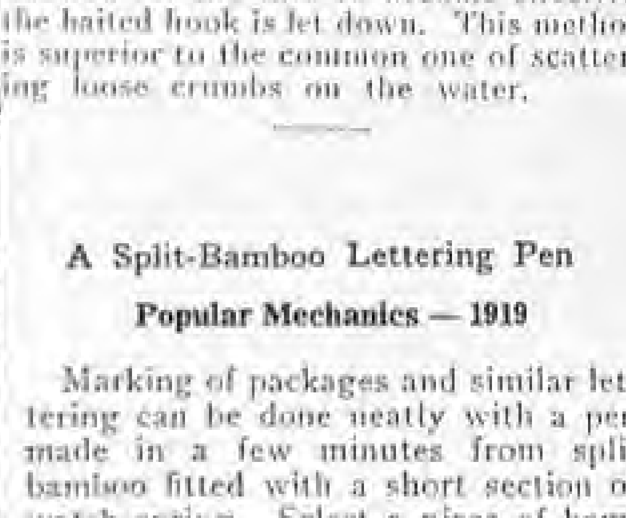
Fish can be attracted to the spot where the fisherman is casting, by partly filling a paper bag with bread crumbs and meat scraps, and suspending it in the water. An ordinary paper flour bag is used, and, after it has been filled, weighted, and a cord tied around the neck, it is lowered to within about 4 ft. of the bottom, at the spot selected. Two or three small holes are made in the sides of the bag and this will start a few crumbs falling, which will attract some fish. As the crumbs are seized upon by the fish, and other crumbs continue to fall, still more fish will be drawn to the spot. After a suitable interval has been allowed for the lure to become effective, the baited hook is let down. This method is superior to the common one of scattering loose crumbs on the water.



A Split-Bamboo Lettering Pen

Popular Mechanics — 1919

Marking of packages and similar lettering can be done neatly with a pen made in a few minutes from split bamboo fitted with a short section of watch spring. Select a piece of bamboo, 1/4 by 1/16 in. and about 7 in. long, and finish the end, as at A. Trim the end to an angle, as at B, and then point it, as at C. Split the point carefully, as at D, and smooth away the tufts at the edges. Cut a piece of watch spring the width of the pen point and bind it into place, arched as shown. To use the pen, insert ink into the arch of the



This Pen, Cut from a Piece of Bamboo and Fitted with a Spring Fountain Device, Is Especially Useful for Marking Packages

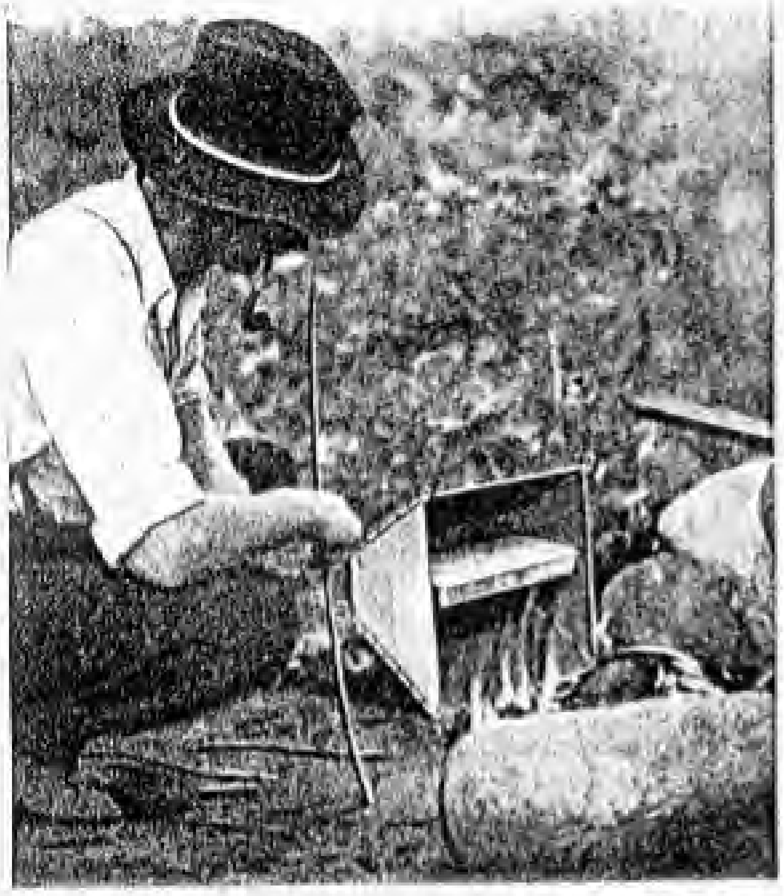
spring, and it will work much like a fountain pen.

Folding Reflector Baker

FOR MAKING HOT BISCUITS AND CAKES IN CAMP

POPULAR SCIENCE MONTHLY

August, 1935



With this baker, you can watch your cakes to avoid burning

BEFORE you start on your next camping trip, spend an hour or two in making this reflector baker. You will be well repaid for the effort in nicely browned, hot biscuits.

Materials. Flat, bright tin, 13 by 42 in.; 11 ft. of iron wire, ⅛ in. in diameter (cut into six 12-in. pieces, two 9-in., one 30-in., and two 6-in., *not rolled!*); ten ¼-in. iron rivets, and a baking pan about 1 by 7 by 11 in.

Tools. Scratch awl, tin snips, pliers, cold chisel, center punch, drill for rivets, file, and hammer.

Construction. Lay out tin as in Fig. 1 and cut on all heavy lines. The two slots in the 4-in. piece are made with the cold chisel and should be only as wide as two thicknesses of the metal.

Turn and finish the edges that are to be permanently wired. Then bend the tabs along the edges that are to be hinged (Fig. 2). Match the edges, insert the wires, and test the hinges. The ends or short sides of the 4-in. piece are bent up at right angles to the surface and in the opposite direction to the tabs.

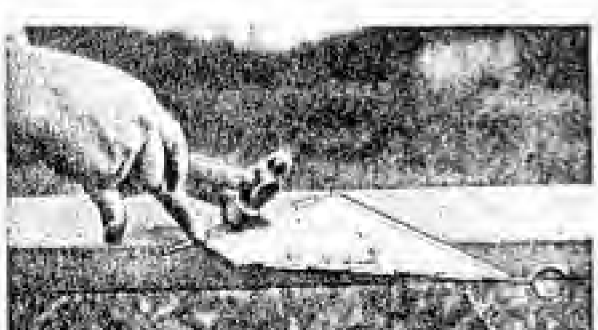
Two of the 12-in. wires are pointed on one end, and a ring about 1 in. in diameter is formed on the other. These two wires are removable to allow the baker to be folded for carrying. The other hinge wires are retained in place by pinching the tabs on the ends.

The 2-in. wide pieces of tin are bent into three thicknesses each and drilled and offset as in Fig. 5 to form the rear legs. Rivet these in place about 2½ in. from the sides of the back.

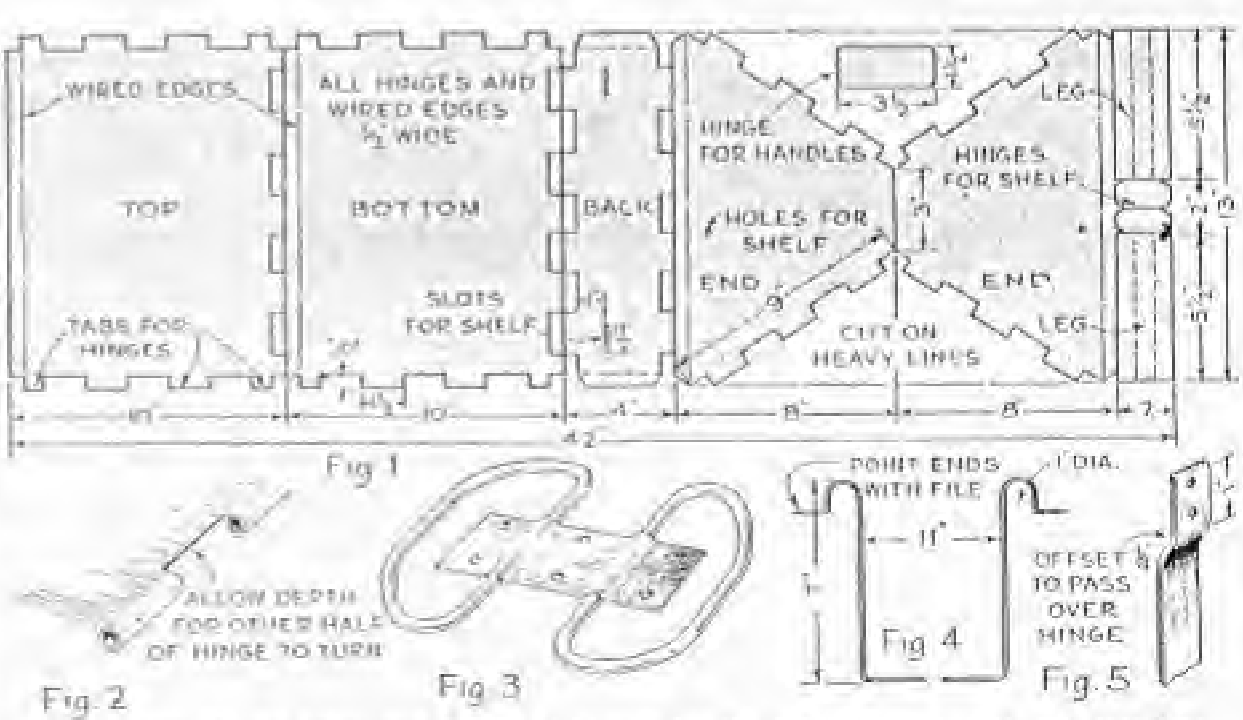
The support or shelf for the baking pan is made from the 30-in. length of wire as in Fig. 4. Bend two pieces of tin around the wire and pinch them together so that the ends can be inserted in the slots previously cut in the back. When the wire is down snug against the back piece, bend the ends of the small pieces over against the back and hammer down. Set baker in position, tilt shelf until horizontal, mark position of wire points on sides of baker, and drill holes. Spring shelf apart slightly at front so that the wire will snap into the holes.

For convenience in handling baker when hot, a wire handle may be added to top as shown in Fig. 3.

Use. The baker depends upon reflection so it is important that it be kept bright at all times. A canvas or leather carrying bag will help to protect it.—LEONARD F. MERRILL.



The hinge tabs are bent over a piece of wire

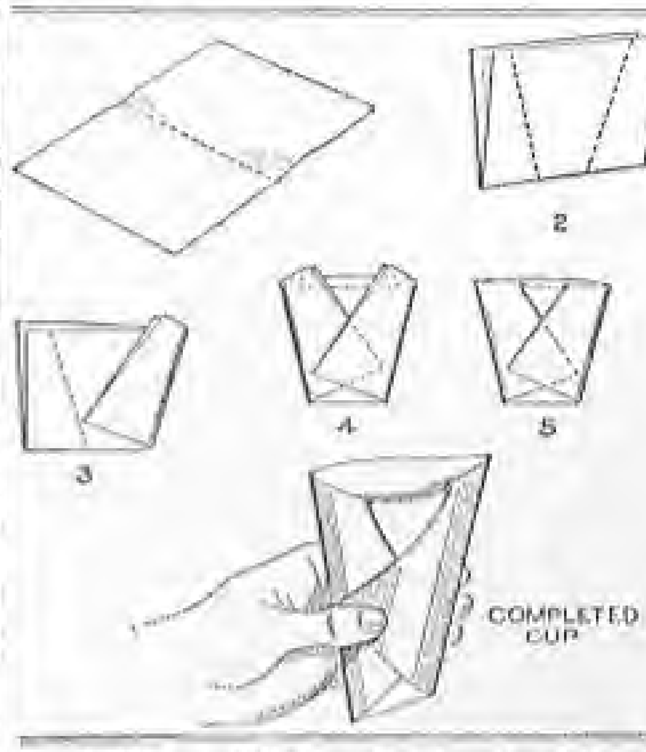


A pattern for the baker and details of hinges, handle, baking-pan support, and rear legs

Making a Paper Drinking Cup

Popular Mechanics — 1925

A simple method of making a paper drinking cup is shown in the illustration. The sheet of paper is regular business size; 8½ by 11 in. The piece is first folded in



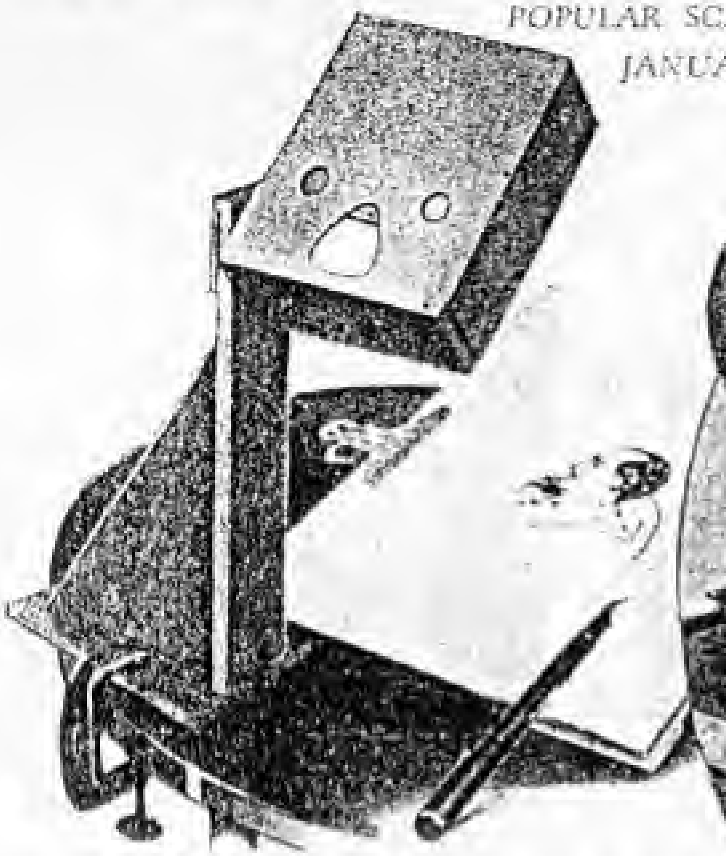
Simple Method of Making a Drinking Cup of Paper

half as shown in Fig. 1, then diagonally as shown in Fig. 2, and the projecting corners are turned over the edge of the cup, which completes it. The strength of the cup, of course, depends on the kind of paper used.

OIL PROLONGS RAZOR'S LIFE

MEN who use metal safety razor blade sharpeners will find that a drop of lubricating oil well rubbed over the surface will improve the shaves considerably and prolong the life of the blade.—ARTHUR B. WEEKS.

POPULAR SCIENCE MONTHLY
JANUARY 1933



By looking into the device, you can see, as if projected on the paper, exactly what you wish to draw. All you need do is to trace the outlines carefully

MAGIC *Sketching Spectacles*

By
GAYLORD
JOHNSON

Make It Possible for You to Draw Anything Accurately—Models, Objects, Landscapes, Portraits, or Copies of Plans and Photographs

DRAWING is the language of the mechanic. Whenever you set out to make anything more complicated than a shelf or a box, it is necessary either to sketch your own design or to use some other designer's mechanical drawings—drawings such as those illustrating so many of the articles in this department. In either case the information is given by means of lines and dimensions, not words. This explains why it is that every mechanic, whether amateur or professional, takes a keen interest in drawing, and why many of them are either skillful draftsmen or adept at making understandable sketches.

Not so many, however, can make a good free-hand perspective drawing from an object, a building, or a landscape, or can even copy pictures that involve a knowledge of perspective. Still more rarely is it possible for one not trained in art work to make a good, recognizable portrait sketch. Yet it is amazingly easy to do all of this with the aid of the device illustrated, which can best be described as "sketching spectacles." This instrument enables you to see what you want to draw as if projected right on the paper. All you have to do is to trace the outlines of the various parts with a pencil in order to draw everything just as it should be—the shape, proportions, perspective, details, and light and shade.

The construction of the "spectacles" is explained in the drawings on the following page. The operation of the device depends upon the two mirrors *A* and *B*, placed in their boxlike container at the angles indicated, with their reflecting surfaces facing each other so that light will be reflected from one to the other.

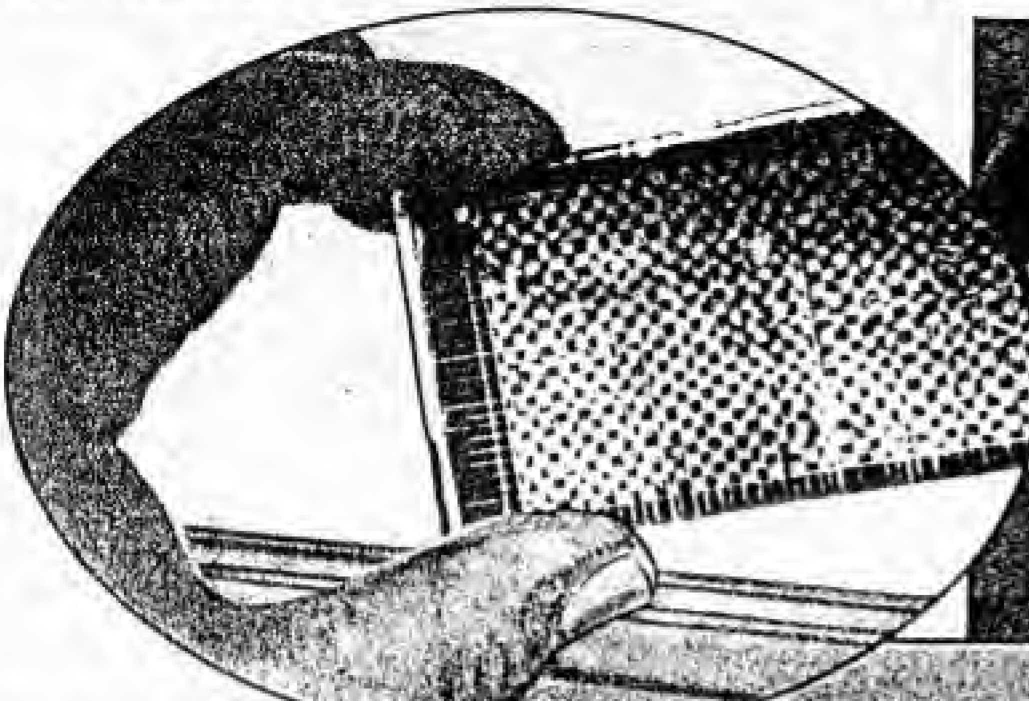
The silvered coating of mirror *A* is continuous and unbroken, but part of the silver on mirror *B* has been scratched out in a pattern of tiny checkerboard squares, as shown in one of the photographs. This removes approximately half the mirror surface and allows the eye to see an object placed behind the mirror and, at the same time, the image of another object reflected from the tiny squares of silver that remain on the glass.

The application of this to sketching is made clear by the diagram. The course of a ray of light from the subject to be drawn is indicated by the line of heavy dashes. This ray meets the surface of mirror *A*, is reflected to one of the silvered squares on mirror *B*, and thence to your eye. The course of a ray of light from the pencil point to the eye is shown by the light dotted line. This ray goes straight through the clear glass of one of the scratched-out squares of mirror *B*. As a result, you see the pencil through the mirror image of your subject, and can trace the outlines of the image easily upon the paper. Later, you can finish your drawing in any way you please—for example, in pen and ink or water-colors—without the aid of the "spectacles."

To insure accurate proportions, you should take care to place the drawing board at a slant, with its surface parallel to that of mirror *A*. Also, in sketching by artificial light, you must illuminate the pencil enough so that it is seen as distinctly as the subject to be drawn.

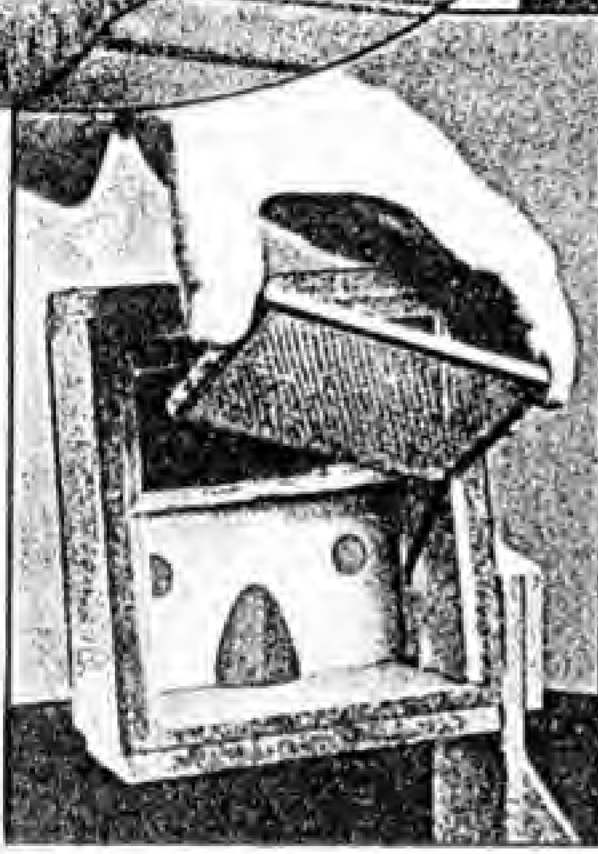
In the model illustrated, the box is made of composition fiber board except the two side linings in which the slots for the mirrors are cut and the front piece with the eyeholes and nose "bridge." These parts are cardboard. Wood could be used throughout.

Mirror *B* was ruled in 1/16-in. squares. This is easy to do with a drawing board, T-square, and any sharp-pointed tool, such as the V-gouge of a set of carving

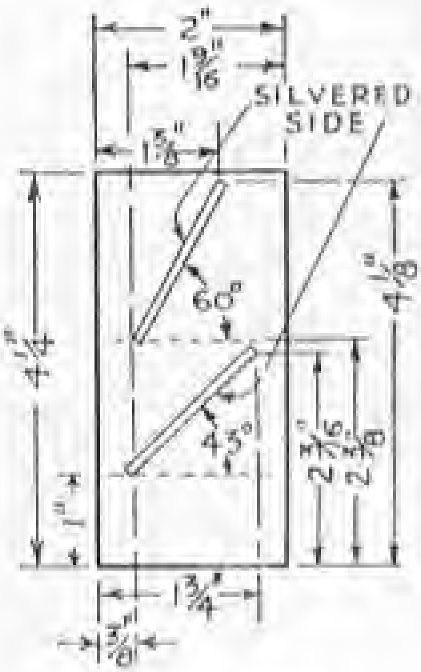


The silvered surface of mirror *B* is divided into 1/16-in. squares, and the silver is scratched away from every other division

Laying out squares on mirror *B* with a T-square and a small wood carver's V-gouge. Any sharp-pointed tool could be used



The sketching box as it appears from the rear. Mirror *A* is in place and mirror *B* is about to be pushed into its grooves



How the mirrors are placed in relation to the inside of the box

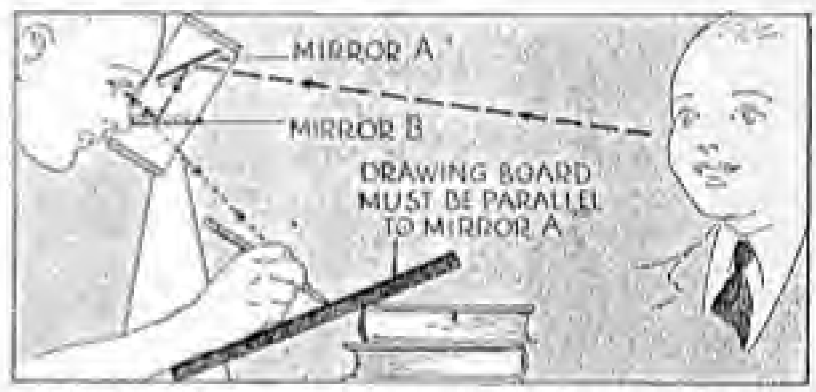
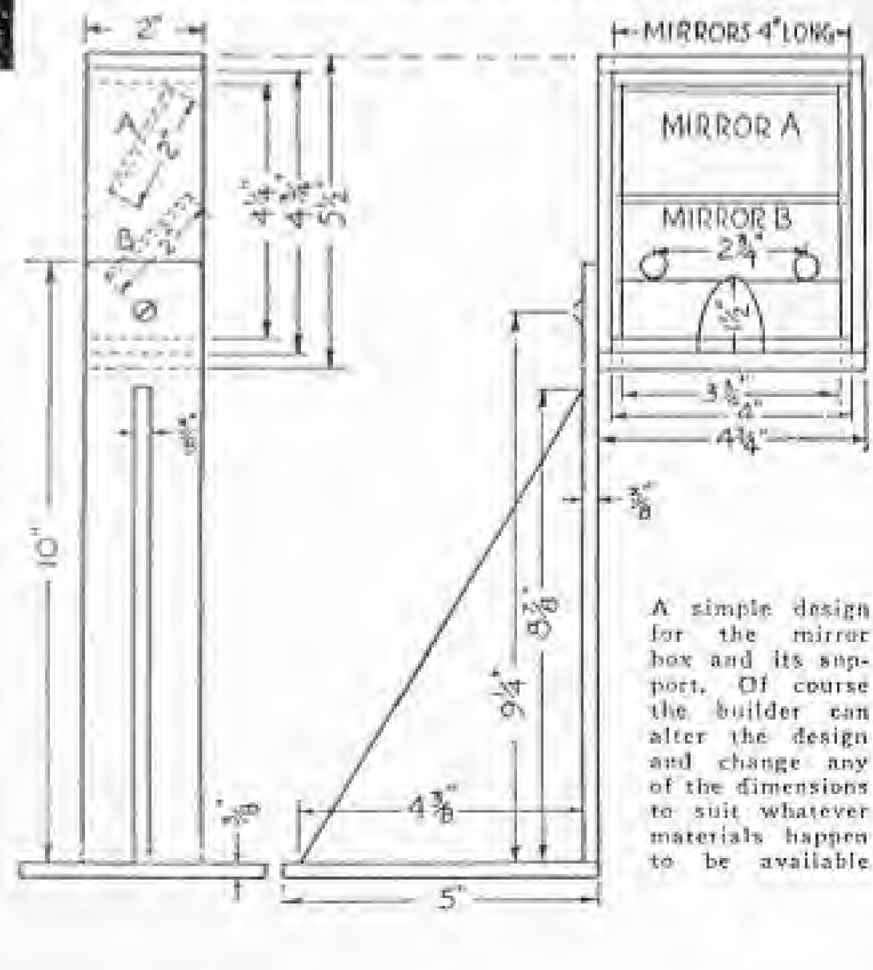


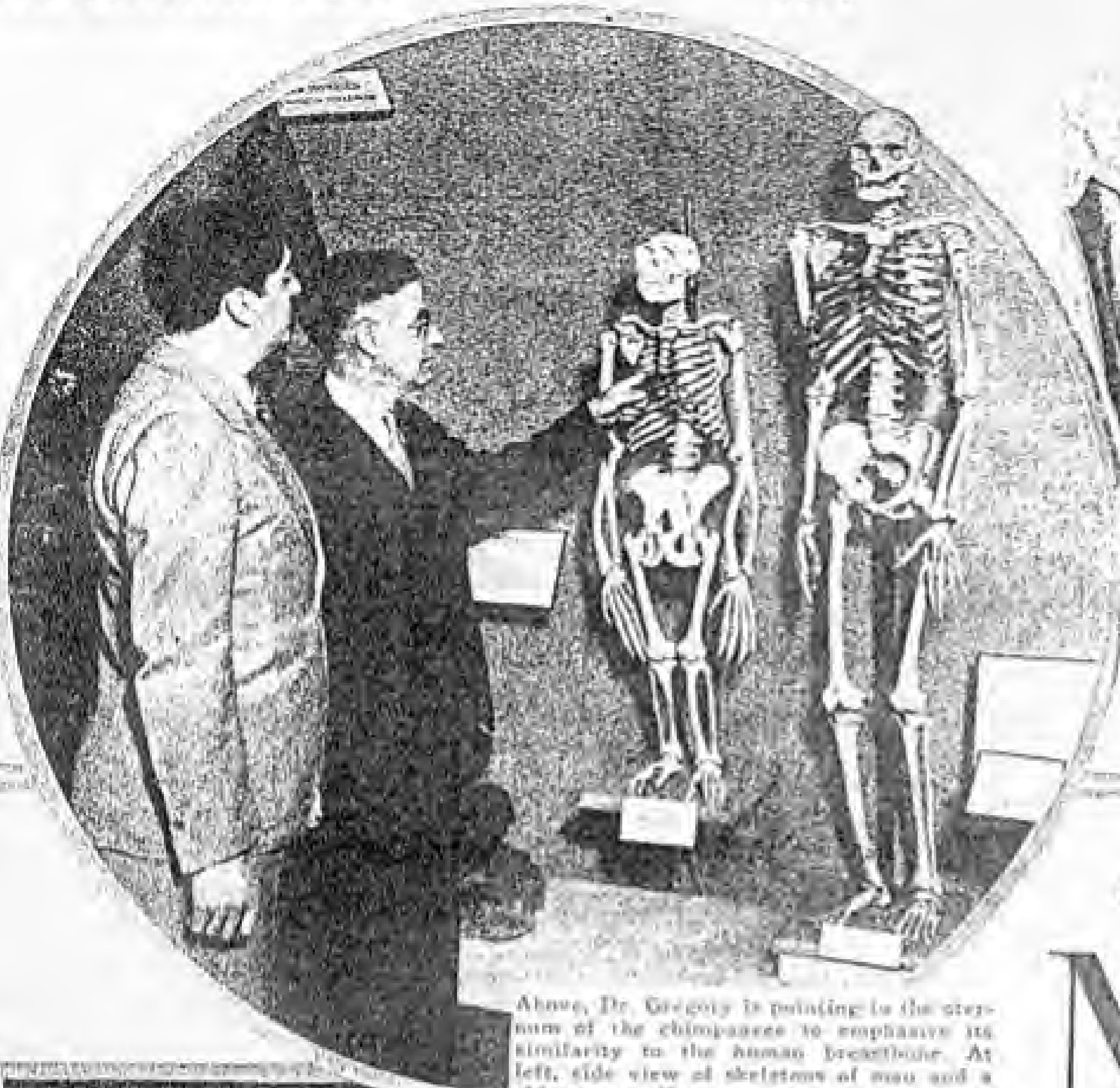
Diagram showing why the user is able to see a reflected image of the subject as well as the point of his pencil



A simple design for the mirror box and its support. Of course the builder can alter the design and change any of the dimensions to suit whatever materials happen to be available

tools. Then every other square can be scratched out with a penknife while the mirror is pressed against a window pane.

Since successful sketching depends upon keeping the image of the subject immovable, it is necessary to guard against moving your head and eyes while sketching. This is accomplished by making a "spectacle bridge" for your nose and keeping the nose in contact with it. The box is, of course, pivoted to the standard, and the latter is clamped to the table. Most persons will find it helps to close one eye when sketching in the outlines.



This spectral tarsier, a strange monkeylike creature with big eyes, still lives in Borneo and in the Philippines.

POPULAR SCIENCE MONTHLY
SEPTEMBER, 1931

Above, Dr. Gregory is pointing to the sternum of the chimpanzee to emphasize its similarity to the human breastbone. At left, side view of skeletons of man and a chimpanzee. Note more erect posture of the man and "S" shape of his spinal column.

MAN *Is* *Still a* Monkey

What They Talked About

DR. WILLIAM K. GREGORY, the distinguished scientist of the American Museum of Natural History, has told Michel Mok, staff writer, how the earth and life originated, and how man got his face and other bodily parts. Life appeared a billion years ago in mud and puddles in the shape of tiny bits of jelly, probably the products of ancient chemical forces, which developed into cell-groups, into small wormlike creatures, into air-breathing fishes that became our ancestors.

MR. MOK: Dr. Gregory, you told me last month that we got our upright position from the monkeys. You subscribe, then, to the theory that we are descendants of monkeys?

DR. GREGORY: That is no longer a theory, but an established fact. We are not only descendants of monkeys, but we still *are* monkeys. To complete the collection in the monkey house at any zoo, there should be a man behind the bars. As it is, the only monkeys not in cages are the spectators and keepers.

MR. MOK: I am afraid you would have a hard time finding a volunteer. People are too modest. Everybody would concede at once that the other fellow was a finer specimen. But I suppose you are only joking?

DR. GREGORY: Indeed I am not. I am stating a scientific fact. When a man is watching an inmate of the monkey house, you have representatives of two species of monkeys looking each other over. Both are actuated by one of the outstanding traits of the monkey family—curiosity.

MR. MOK: Of course, I am familiar with the idea that we may have descended from monkeylike ancestors. But why do you say that we are still monkeys? That idea is new to me. Whose is it—Darwin's?

DR. GREGORY: Most people associate it with Darwin because he put it "on the map," so to speak. But it is much older. In 1759, just half a century before Darwin was born and precisely one hundred years before he published his famous book, "Origin of Species," Linnaeus, the great Swedish scientist, discovered that man was a mammal. In fact, it was he who coined the word mammal as a name for the animals that bring living young into the world and suckle them. He then placed man in the Order of Primates, which means literally the first, or highest, order of mammals. It comprises all the monkeylike forms, including the manlike apes.

MR. MOK: But Linnaeus might have been wrong!

DR. GREGORY: He might have been,

SCIENTIFIC *facts in the history of human beings are told in this dialogue in which is continued the story of* LIFE...the World's Greatest Mystery

Dr. Gregory: I see you have been looking at the funny pictures in which stone age men are chased out of their caves by dinosaurs. But all these huge reptiles had died millions of years before man was man.

but he was not. Nothing has happened since 1759 to take man out of the Primate group. On the contrary, literally thousands of facts have been found that prove Linnaeus' contention. That is why I said we still are monkeys.

MR. MOK: What are those facts?

DR. GREGORY: I will come to them after a while. First, I want to tell you something of the origin of the idea. Even in Linnaeus' time, the theory, in a general way, was by no means new. The idea of evolution usually is credited to Lucretius, the Roman poet, who lived in the first half of the first century B.C. Do you know what is meant by evolution?

MR. MOK: The development of all living things from lower forms.

DR. GREGORY: Not all. The evidence shows that the progress generally has been from the simpler toward the more highly organized and specialized types, but the opposite also has occurred. Evolution simply is the Latinized version of the word unrolling or unfolding. The theory of evolution, therefore, teaches that life unfolded slowly instead of having been produced suddenly. Lucretius first suggested the idea of creation by necessity rather than by special decree of the gods.

MR. MOK: If life appeared by evolution, why is it not continuing to be produced in that way?

DR. GREGORY: Life is continuing to evolve, as it has in past ages, and at the same extremely slow pace. Don't forget that it took more than a billion years to create man!

MR. MOK: What is the animal just below man?

DR. GREGORY: The chimpanzee.

MR. MOK: Do you mean to say, then, that, given enough time, the present chimpanzee will evolve into man?

DR. GREGORY: Certainly not. First, man did not evolve from a chimpanzee, but from a common ancestor of both chimpanzee and man, as I will explain later. Secondly, Nature never repeats itself in the creation of a new species, and it already has produced man.

MR. MOK: To come back to Lucretius—was his idea forgotten until Linnaeus took it up again?

DR. GREGORY: Not exactly. In 1699, Edward Tyson, an English anatomist, dissected an ape specimen, now known to have been a chimpanzee, and showed that its anatomy closely approached ours. But he did not establish any relation. This was first done by Linnaeus. After that came Lamarck, the French naturalist, who died in 1829. He was Darwin's immediate predecessor both in the general theory of evolution and in the idea that man derived from an upright-walking ape. This idea was so distasteful to many people that other French scientists put man in an order by himself, which they called *bimana*, meaning the two-handed.

MR. MOK: Then Darwin, you might say, was a disciple of Lamarck's?

DR. GREGORY: No, he paid little attention to Lamarck's work. At first, he did not even devote himself to the subject of man. For many years, he made an exhaustive study of animal and plant life. When he did take up the subject of man's place in Nature, he reached his conclusions independently through first-hand study of the facts.

MR. MOK: As I understand it, these evolutionists, from Linnaeus to Darwin, taught that man is descended from a monkey or a monkey-like animal.

DR. GREGORY: Yes, and we still do.

MR. MOK: How did they know?

DR. GREGORY: Because of the structural resemblance between man, the apes, and the monkeys. As a matter of fact, the anatomy of a manlike ape is more like ours than like that of the lower monkey forms. I have explained to you that structural resemblance proves relationship.

MR. MOK: You have. But does it prove descent? How do you know that there were no men on earth long before the monkeys?

DR. GREGORY: Are you hinting that the monkeys are descended from man? Some scientists have seriously entertained that idea, just as some have tried to show that the fishes were descendants of land animals rather than the reverse. I regard that as a first-class example of a topsy-turvy view of things. If it were true, then man would have been the first creature on earth, and all the simpler forms would have been derived from him.

MR. MOK: I was not hinting at such a possibility. What I would like to know is this: Why may there not have been men, say, in the age of the reptiles?

DR. GREGORY: Ah, now I see what has happened. You have been looking at those funny pictures in which stone-age men are chased out of their caves by dinosaurs. But all those huge reptiles had disappeared for scores of millions of years before man became man.

MR. MOK: What makes you so sure? Why may there not have been men around in any age, no matter how early?

DR. GREGORY: The "why-may-not" style of argument never proved anything. It is used mostly by those who wish to dodge the direct evidence of scientific facts.

MR. MOK: I assure you I have no such wish. What is your direct evidence?

DR. GREGORY: You are convinced that man is a backboned creature, aren't you?

MR. MOK: He should be.

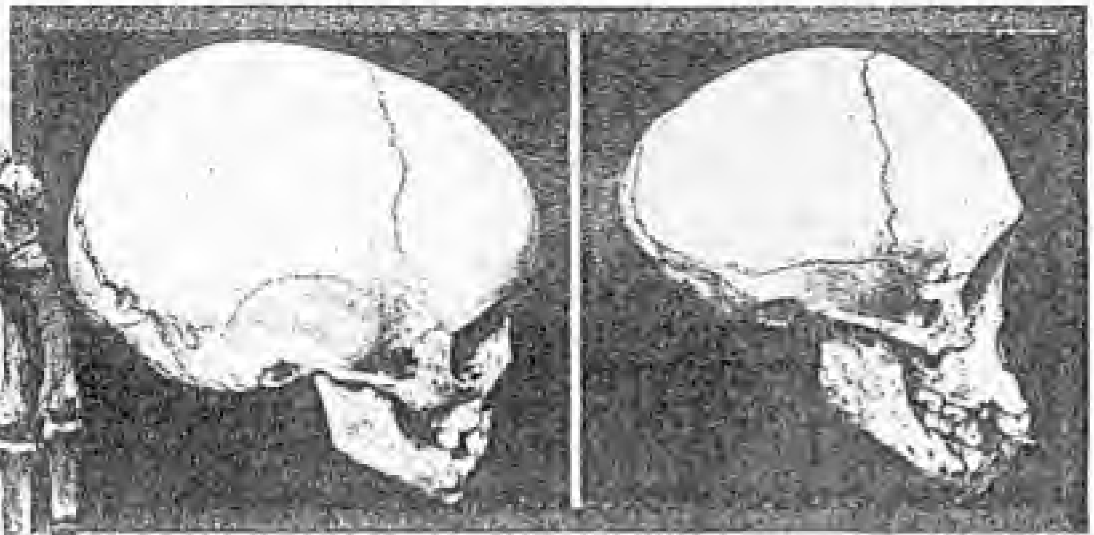
DR. GREGORY: Fine. We have a life record of the backboned animals stretching back over a period of something over four hundred million years. True, this record is broken, at intervals, but still we have tens of thousands of specimens, actual fossils from hundreds of localities and representing scores of successive stages in the history of the earth.

MR. MOK: What good is this huge mass of old bones in proving that man followed the monkeys and not, say, the early fishes?

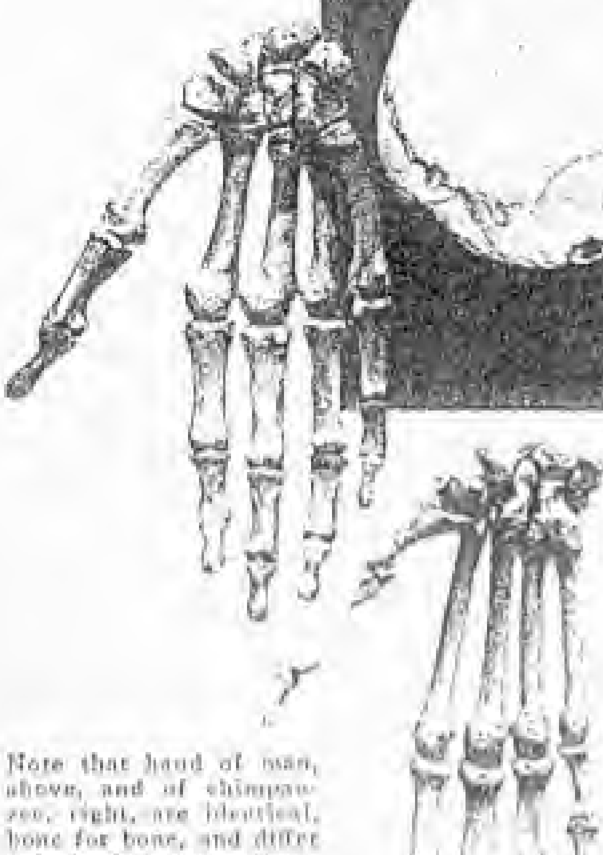
DR. GREGORY: Because in each rock layer, dating from some definite age, fossils of certain creatures were found and others were not.

MR. MOK: In other words, because no human bones were unearthed from the same rock layers that contained, for example, early reptile fossils, you conclude that there were no people at that time. I call that negative evidence. You merely infer it.

DR. GREGORY: Right. So far, it is an inference from negative evidence. But everything we know in science, except that which is directly observed, is known by inference. It is in that way, for instance, that we know that the sun does not actually rise and set, but that the



At left, skull of human infant; at right, skull of young chimpanzee. The parts of the human skull have the same structure as those of the ape, the difference being due to brain expansion and shortening of man's face.



Note that hand of man, above, and of chimpanzee, right, are identical, bone for bone, and differ only in their proportions.

earth alternately produces day and night on either of its hemispheres by whirling around its own axis. Nobody ever has seen the earth whirl. In daily life and law, the same thing holds good.

MR. MOK: For example?

DR. GREGORY: My ancestors came from Devonshire, in England. Let us suppose for a moment that a sum of money is left to me because I am the last of my name in the male line. Just as I am about to claim my inheritance, up bobs a chap named Gregory, who says he comes from a certain town in Devon, is my cousin, and demands half the estate.

MR. MOK: What has that to do with the monkeys?

DR. GREGORY: One moment, please, and you will see. I never heard of the fellow, so I have him looked up in that place in Devonshire. There is no mention whatever of him there in the directories, municipal and church parish records, tax records, and the like. That is negative evidence that he did not come from Devonshire. But that is only half the story.

MR. MOK: Don't tell me he is your cousin, after all!

DR. GREGORY: Far from it. While one of my private detectives looks him up in Devonshire, another clever sleuth discovers that a man of that age, and answering my "cousin's" description in every detail, lived in a small town in Poland until ten years ago. His name was Gregorowski. He changed it to Gregory. What would you call that?

MR. MOK: Positive evidence.

DR. GREGORY: Exactly. So then I have, first, negative evidence that he was *not* born in Devonshire, and, second, positive evidence that he *was* born in Poland. Well, we have a similar situation in this business of man's place in the history of life. We have negative evidence that he did not live, for example, in the age of the dinosaurs, and positive evidence that he did live scores of millions of years later. Is that clear?

MR. MOK: Clearer than it was before. Still it seems to me that your anecdote does not fit the case exactly. Suppose all the municipal and parish records in the Devonshire town had been destroyed in a fire? What I mean is this: Is it not possible that no human remains were found in the earlier rock layers because of earthquakes or other upheavals?

DR. GREGORY: That would not cause them to be consistently absent for nearly four hundred million years, and consistently present in much later periods. In this one museum alone (The American Museum of Natural History—Ed.) there are no fewer than 44,661 catalogued fossil specimens of backboned creatures, and not a single one of them was found in a rock layer in which it did not belong chronologically. A broad view of the fossil record of life, of which this collection is only a very small part, shows that the general trend of life's development was from fish to man, and not the reverse. That being the case, man followed the monkeys.

MR. MOK: Can you prove this specifically?

DR. GREGORY: Certainly. Fossil remains of men have been found in recently formed rock layers. From older rock layers have come fossils of apelike men. In still older rock layers have been found fossil fragments of manlike apes. Rock layers more ancient still have yielded remains of small apes. In layers formed before that time, not a trace of apes has so far been discovered, but fossils of small monkeylike creatures have been found in them. Now, this is the evidence of the rocks. Evolution, however, is supported by three kinds of evidence.

MR. MOK: What are the other two kinds?

DR. GREGORY: The evidence supplied by the study of the structure of animals, particularly as it shows their relation to each other and to us; and the evidence furnished by the study of the formation and development of unborn creatures. But before we go further into this matter of evidence, let me make something clear to you. It is this: Since Darwin's time—that is, roughly, in the last seventy-five years—so much evidence of the three kinds I mentioned has been gathered, and of several other kinds besides, that now there is a mountain of it. Most of it, by the way, completely vindicates Darwin's views. Personally, I have devoted a lifetime to an examination of this evidence; thirty years, to be exact. Other investigators have done the same thing. The libraries of the world are filled with books on the many ramifications of the subject; some learned men have given their lives to the study of one detail. It stands to reason that all we can do in a talk of this kind is to touch some of the high spots.

MR. MOK: I understand that.

DR. GREGORY: All right. As for the study of unborn creatures, I told you last month that the unborn human baby, in its various stages, presents a blurred record of man's development from the earliest forms. You remember that, in turn, it has characteristics of a one-celled creature, a worm, a fish, an amphibian, a lizard, a hairy mammal, a creature with short legs like an ape and, lastly, a man.

It does not begin as a man and end up resembling a fish or a worm, or as a single cell. The evidence in the development of the unborn baby, therefore, supports the evidence of the rocks.

MR. MOK: What does this study show

about our monkey descent?

DR. GREGORY: From its beginning as a fertilized egg cell until it is born, a human baby undergoes a series of elaborate changes. Investigations by the late Dr. Emil Selenka, an eminent authority on this subject and others, have shown that similar changes take place in the unborn young of only four other mammals. These are the gorilla, the chimpanzee, the orang-utan, and the gibbon.

MR. MOK: You mean that the human baby and the young of these apes resemble each other in the corresponding stages of their development before birth?

DR. GREGORY: That's it. For instance, if you compare an unborn baby with an unborn young of a chimpanzee or a gorilla in the corresponding stages, you will find them amazingly similar in general appearance. In both cases, for instance, the soles of the feet can be turned toward each other, just like the palms of hands. After birth, the apes retain and develop this feature; as you know, their feet become much more handlike and grasping. In us, the foot changes so as to support our weight in the upright position; though, as we saw last month, a human baby's foot is still somewhat apelike for a while after birth.

MR. MOK: Will you give me another example?

DR. GREGORY: Here is a striking one: In most of the later half of its life before birth, the human baby's body is covered with short, downy hair. So is that of the unborn ape-young in the corresponding period. Both lose their hair before birth, grow long hair on the head, and are born with hairless bodies. We remain that way, while the young ape soon grows a new coat. So, you see, in this case we retain the pre-natal condition, while the apes retain it in the case of the feet.

MR. MOK: Aren't there any points of difference?

DR. GREGORY: There are, but they are mostly differences in proportion. Curiously enough, the unborn chimpanzee is more human in its proportions than the adult chimpanzee. On the other hand, a child is more apelike in its proportions before birth than after. For instance, compared with a man an adult chimpanzee has longer arms and shorter legs in proportion to the body. This is true, too, when you compare an unborn chimpanzee with an unborn child; but the difference then is much smaller. Before birth, the shape of the chimpanzee's skull also is much more human than in the adult. Now, all these things are regarded by scientists as evidences of relation; that is, common ancestry.

MR. MOK: Are all scientists evolutionists?

DR. GREGORY: Science is a broad field and I am, therefore, unable to answer your question. What I *can* tell you is that all competent authorities on the subject of natural history are evolutionists.

MR. MOK: How do you know?

DR. GREGORY: Because I have never seen any professional paper published by the leading scientific journals of the world in which the broad fact of evolution was questioned for a moment.

MR. MOK: Still, a good many books are published that attack evolution.

DR. GREGORY: Yes, but their authors have no standing in the scientific world. No member of the National Academy of Sciences, of the American Philosophical Society, or of the New York Academy of Sciences is an antievolutionist.

MR. MOK: Surely, membership in those learned societies does not include a share in a monopoly on scientific truth?

DR. GREGORY: No, but it is a guarantee of recognized scientific accomplishment. However, let me ask you a question. If you wanted evidence on any subject, where would you go?

MR. MOK: I should go to an expert.

DR. GREGORY: Yes, but he must be a practical expert. For example, if you want to find out something about the workings of radio, you go to a practical radio man. You don't go to a pastry baker, no matter how skilled and respected, and especially not to one who is known to have an intense dislike of radio. The unfortunate situation in this field is that most people who fight evolution know far less about it, in a practical way, than the young fellows who build their own radio sets know about radio. I have never read any book against evolution which showed that its author was a man who, if I handed him a fossil bone, could tell me that it was, say, from the left side of the hind foot of a certain dinosaur. A man with the kind of training that would enable him to criticize evolution, would know. Most opponents have little more than a personal dislike of the idea, and a more or less developed talent for argument. But let us get back to our evidence.

MR. MOK: You have told me something of the evidence of the rocks, and that found in the development of unborn children and apes. What of the third kind—structural resemblances?

DR. GREGORY: Their name is legion. Naturally, you have seen for yourself, at the zoo, that the manlike apes outwardly look a good deal like us.

MR. MOK: Delightfully like some of us!

DR. GREGORY: Certainly. That is because they are our poor relations. Have you ever had a chance to watch a mother chimpanzee with her young?

MR. MOK: I have.

DR. GREGORY:

Then you must have been impressed by her actions. She fondles the young one, pats it on the head, almost kisses it; a rather touching resemblance to the actions of a human mother, which no lower animal shows. But such things are matters of behavior, and that is a different story. As for physical resemblance, that goes much deeper than any number of visits to the zoo could reveal to you.

MR. MOK: Please give me some of the points of similarity.

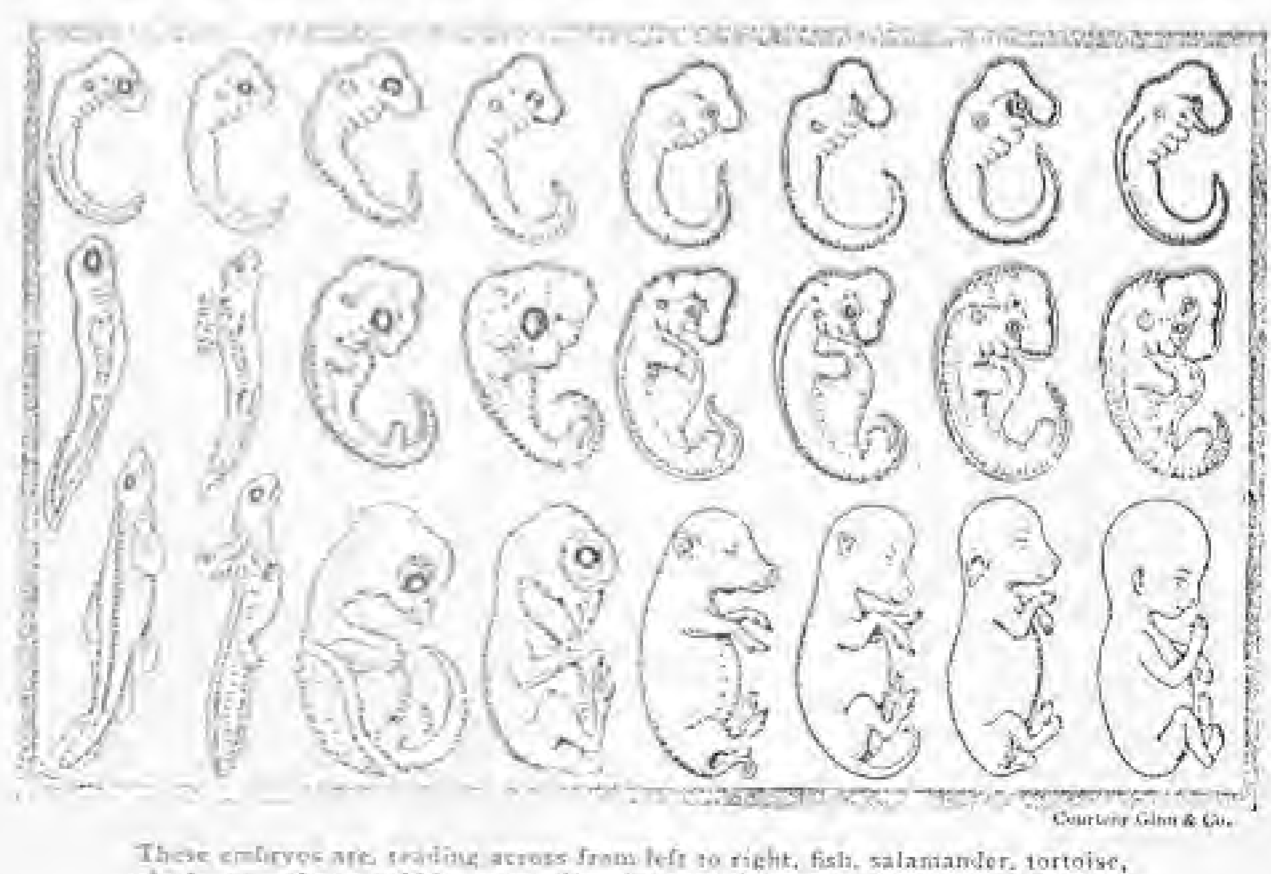
DR. GREGORY: Here you are: Our skeleton and that of the manlike apes are not only built on the same plan; they actually correspond bone for bone. The only differences are in proportions and posture. They have grasping hands, like ours; they can move their thumbs opposite their other fingers, as we can, though not as freely. They have nails on their fingers and toes, as we have. They have the same number of teeth that we have—thirty-two—if we include the wisdom teeth. They have no outward tail, and neither have we. But they do have a tail remnant, and so have we. They have an appendix, and we have, too. Their females have a single pair of breasts. Then, there is the brain.

MR. MOK: Their brain is not like ours, is it?

DR. GREGORY: It is like ours, only smaller and less developed. We have not a single brain structure that the manlike apes do not possess. Dr. Elliot Smith, of London University, has shown that, while our brain case and brain are larger in proportion, this increase is caused by enlargement of parts that are present in the brain of apes. Because of their manlike brain, the apes, especially the chimpanzee, have a greater learning capacity than any other animal. That is the reason for the amusing performances by trained apes that you have seen in the movies and on the stage. Better than that—they are the only animals that know how to anticipate experience.

MR. MOK: What do you mean by that?

DR. GREGORY: They know how to put two and two together of their own accord. There are many examples of this ability on the part of apes. A chimpanzee belonging



Courtesy Ginn & Co.

These embryos are, reading across from left to right, fish, salamander, tortoise, chick, pig, sheep, rabbit, man. Development increases from top to bottom.

to a German zoologist, without being taught the trick, fitted a stick into the hollow end of another to reach a banana. More striking still was the inventive ability of Dohong, the orang-utan at the New York Zoological Park, who used his trapeze as a lever to pry the bars of his cage apart.

The senses of the apes, too, resemble ours in sharpness and range.

MR. MOK: Have they been tested?

DR. GREGORY: Yes. They have stereoscopic vision. They can distinguish colors, while lower mammals—for instance, the dog—are known to live in a gray and colorless world. Their hearing, too, is as acute as ours, and they can distinguish between tones almost as well as we can. But aside from the three principal kinds of evidence I have mentioned, there are new kinds. Modern medicine and chemistry have opened fields that were unknown in Darwin's time.

MR. MOK: What have these sciences shown?

DR. GREGORY: The manlike apes are susceptible to the same diseases from which we suffer, particularly typhoid fever. Chimpanzees in captivity have contracted appendicitis, pneumonia, and influenza. They react to stimulants (including alcohol), sedatives, and poisons exactly as we do. They are even plagued by the same parasites!

MR. MOK: And what has chemistry brought to light?

DR. GREGORY: It has been used mainly to determine similarity in the blood. According to Sir Arthur Keith, the eminent British naturalist, the blood of the manlike apes and ours is chemically the same to the extent that a small quantity of human blood, injected into the veins of a chimpanzee, is immediately absorbed. This test was actually made. Then it was repeated, but ox blood was used instead of human blood. This was destroyed by the chimpanzee's system, and thrown off through the kidneys. Experiments of this kind, Sir Arthur says, have shown that this particular similarity in the manlike apes amounts to a full 100 percent. In the Old World monkeys, to which we are related, it is ninety-two percent; but in the New World monkeys, which are remote relations of ours, it is only seventy-eight percent.

MR. MOK: How do the manlike apes differ from human beings?

DR. GREGORY: Just as in the case of unborn children and unborn ape young, the differences in the adults are only differences of degree—that is, of proportion. I have told you about the size of the brain. Our jaws and the bony ridges over our eyes are smaller, but our nose and chin are bigger. Our feet are less handlike, and the hair on our bodies is much smaller in quantity and shorter. Our thumbs are larger, but our toes are smaller, except the big toe. Our canine teeth are much smaller. Two points of difference are striking. First, we have the ability of speech, and the apes have not.

MR. MOK: Can't monkeys talk at all? I understand that they chatter, and that some investigators believe that they have a language.

DR. GREGORY: A good deal has been said about that, but it has never been shown that they have speech in our sense.

MR. MOK: I should think that our ability to talk and to reason might prove that the apes and the monkeys are not related to us, after all.

DR. GREGORY: It proves that no more than the fact that a child is backward proves that it is not the son of its father. They have the same vocal organs that we have. Moreover, experiments have shown that they have at least the beginnings of reasoning power. Sorry if it depresses you, but all we are are *improved and talking monkeys.*

MR. MOK: What is the second striking point of difference?

DR. GREGORY: Our upright position. This has resulted in some changes in our bodily structure. Our spine is bent in a different way. Ours is in the shape of the letter S; that of the apes is bow-shaped. Our head is placed straight on top of our neck; theirs juts forward. Our legs are straighter than theirs, and our pelvis—that is to say, the bony structure of the hip—has become a flat basin on which the organs in the abdomen rest.

MR. MOK: Where did we get our upright position?

DR. GREGORY: We began to acquire it long before we came down out of the trees.

MR. MOK: Did we ever live in trees?

DR. GREGORY: No, but our ape and monkey ancestors did. You were saved from running on all fours by one of them that was a trapeze artist. These humble, ancient ancestors of ours acquired our upright posture for us by climbing. In monkeys that are living today, you can see the various stages that led to our upright position. Some are merely quadrupeds, running on all fours in the trees, like squirrels. Others reach their arms over their heads in climbing. Still others leap from branch to branch, in upright position, like trapeze performers. These are the clever lads that made real men out of us.

MR. MOK: When and where did we branch off from this ancient ape and monkey ancestral stock?

DR. GREGORY: There are several opinions on these points. You see, in this business of man's descent, there are two distinct kinds of conclusions. One group is based on the evidence of our origin from lower animals that I have told you about. All properly qualified zoological experts agree on four points: First, that man is an animal, no matter what else he may be; second, that he is a backboned animal; third, that he is a member of the Order of Primates; and, fourth, that he belongs to the great branch of the Primates known as the Old World Division. So far, all is agreement. Now come the points where there is room for various interpretations and much need for further light through future research and discovery. These mainly concern the question as to when and where man was freed from the old ape stock.

MR. MOK: But if you scientists are still quarreling, how do you expect to convince us laymen?

DR. GREGORY: I don't expect to convince anybody. All I have been trying to do is to show you some of the things that have convinced *me*.

MR. MOK: What is your personal conviction as to the line of descent?

DR. GREGORY: These are the approximate steps: At the top is modern man. Below him stands the Australian bushman, who carries us back to the Stone Age. Below the bushman come the several fossil species of primitive men that have been found in Europe and Asia. The oldest of these goes back to the beginning of the Ice Age, a million or more years ago. Lower still stand the twenty-odd species of fossil apes from the latter part of the Age of Mammals. Below them come the Old World monkeys from the earlier half of the Age of Mammals. Before them comes the spectral tarsier, a strange, monkey-like creature with big eyes that still lives in Borneo and the Philippines. Below the tarsier is the stage of the lemurs, represented today by their descendants in Madagascar, India, and Africa. Finally come the tree shrews from the latter part of the Age of Reptiles. These are the stages nearest the direct line as yet discovered.

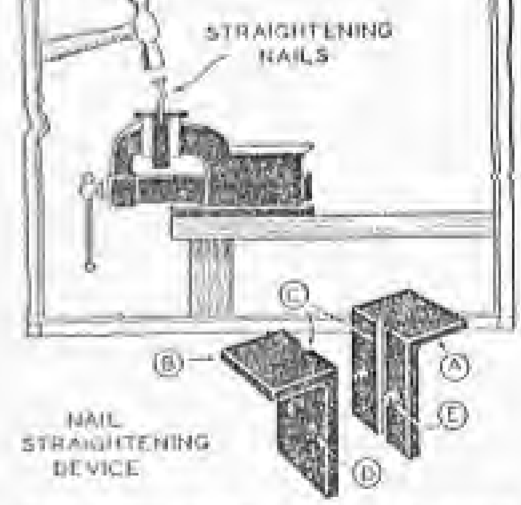
MR. MOK: When did our ancestors learn to walk on their hind legs?

DR. GREGORY: When they left the trees to try their luck at hunting on the plains. This probably happened even before the Great Ice Age.

Popular Mechanic
June 1938

Simple Nail Straightener

A house-wrecking company saw an additional profit in reclaiming the larger nails and spikes that were pulled out of the lumber. After trying several methods, they adopted the one shown. With it, a boy can easily straighten a huge quantity of these large nails in a day. A couple of heavy angle irons (A and B) are clamped together in a drill vise, and a hole drilled between them so that half the hole is in each piece as shown (C). This hole is slightly larger than the diameter of the nail. Several holes of different sizes, to accommodate different sizes of nails, may be drilled in the block. A couple of guide holes are drilled in one plate (D) and holes to match in the other; and short pins, about half an inch long, are set in these holes as shown at (E). The device is placed between the jaws of a vise; the vise drawn tight, and the nail driven into the hole as shown. A half-turn of the vise screw will open



Two pieces of angle-iron plate, drilled as shown and clamped in a vise, will make a nail straightener.

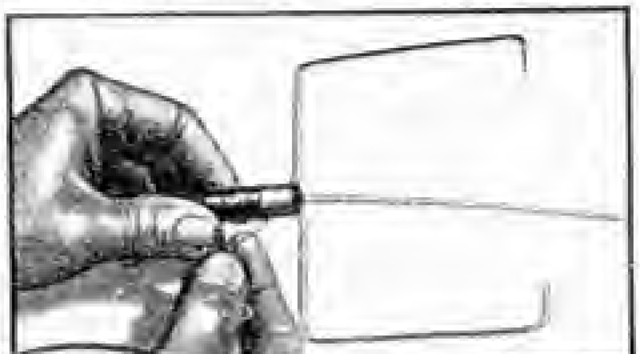
the slot enough to permit lifting the nail with the fingers.—*A. H. W.*

Circus Dog Toy

for Small Children

POPULAR SCIENCE MONTHLY Jan. 1936

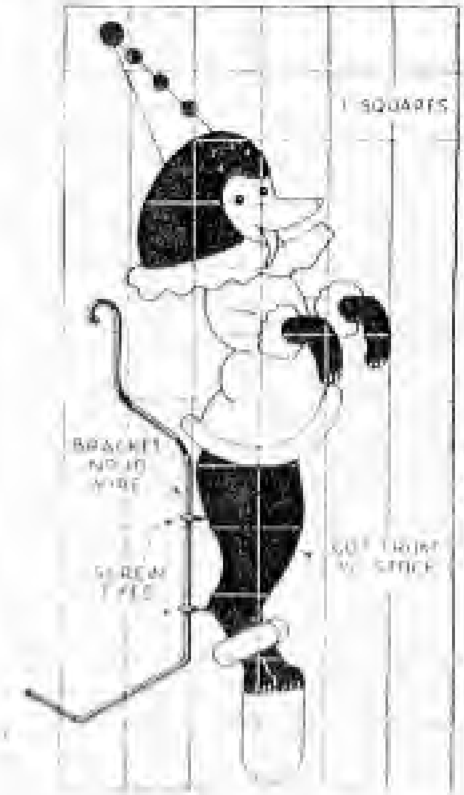
As the toy is pushed along the floor, the dog jumps up and down with a rolling motion

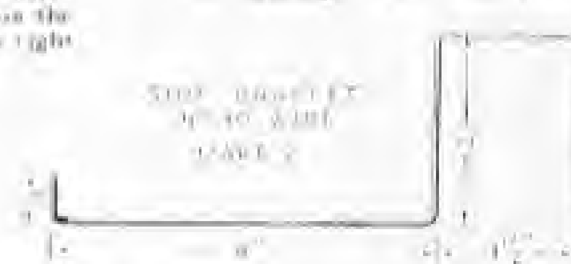


The three wires are set in grooves in the handle and bound with wire. The size and shape of these wires are made clear on the drawings at the right

The cam, which is 3 in. in diameter and shaped like a clover leaf, is nailed to one wheel; then the other wheel is put on

How the center wire is bent after passing through the two screw eyes in the dog's back





THIS circus dog rolling a cylinder is a simple, sturdy, and amusing toy for a small child. The dog is drawn full size on a piece of ½-in. plywood and cut out. The cam, which is 3 in. in diameter and shaped as shown in one of the photographs, is also made from ½-in. plywood. The two wheels, which are 4 in. in diameter, are cut or turned from 1½-in. solid wood. The cam is glued and nailed to one of the wheels; then the other wheel is nailed on. These parts are painted in brilliant colors.

The handle is a piece of ½-in. dowel 22 in. long. It is grooved in three places at one end, and the other end is rounded. The three bent-wire pieces are set in the groves and wrapped with No. 20 copper wire. Solder this assembly securely. Put two small screw eyes in the dog as shown and slide the supporting wire through these eyes before finishing the bending to form the dog's tail. Drill a ¼-in. hole in the center of each roller, put a washer over the holes, and snap in the wires.

As the toy is pushed along, the dog jumps up and down.—RALPH T. MOORE.

Popular Mechanics — 1913

An Egg-Shell Funnel

Bottles having small necks are hard to fill without spilling the liquid. A funnel cannot be used in a small opening, and pouring with a graduate glass requires a steady hand. When you do not have a graduate at hand, a half egg-shell with a small hole pricked in the end will serve better than a funnel. Place the shell in an oven to brown the surface slightly and it will be less brittle and last much longer.

Popular Mechanics
April, 1939

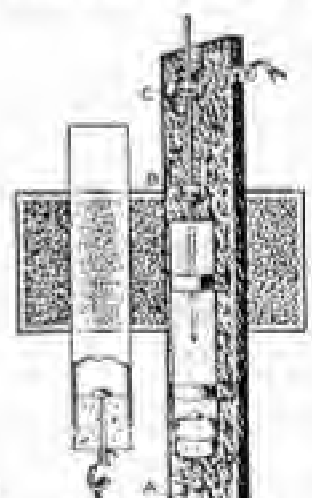
Mouse Trap Clamps Small Parts While Glue Sets

Model makers using cardboard or any thin, light stock will find that a common mouse trap serves as a handy clamp for gluing these materials. The pressure can be equalized by placing a piece of plywood over the work.—J. P. Driscoll, Buffalo, N. Y.

Water Rheostat for Small Electrical Devices

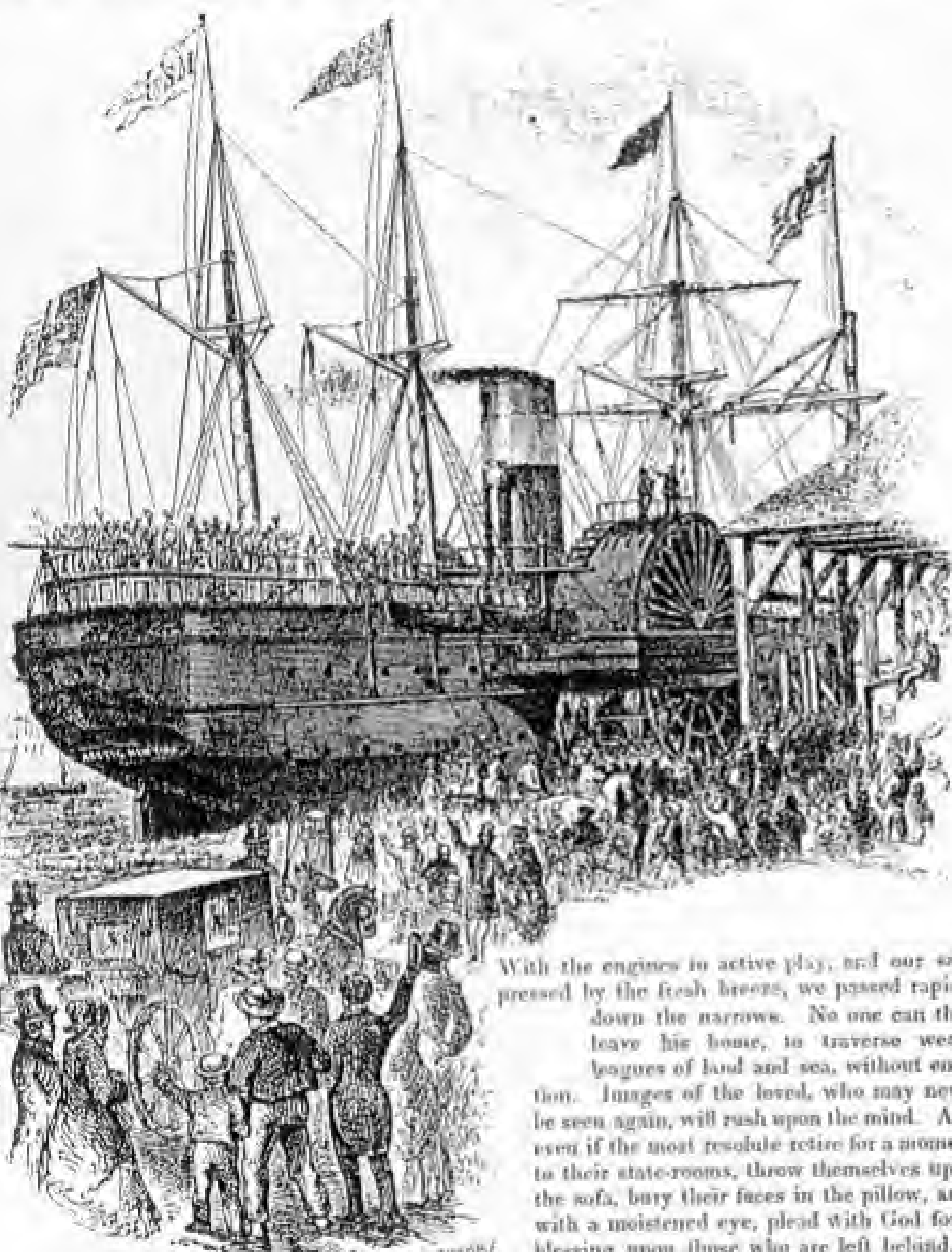
Popular Mechanics — 1919

The rheostat shown in the illustration can be made quickly and at small expense. The base consists of a piece of wood, ½ by 2 by 12 in. A glass tube, 1 in. in diameter and 6 in. long, is fastened to this with strips of sheet metal. A large brass tack is driven into a cork, and the cork is inserted in the lower end of the tube. A wire runs from the brass tack to the binding post A. The lower part of the tube should be paraffined to make it water-tight. A brass or copper rod is placed through the binding posts B and C. The resistance can be changed by sliding the rod up or down. The tube is nearly filled with water having a small quantity of salt dissolved in it. The amount will depend upon the current to be reduced. The rheostat should be fastened to a wall, or other support, and may be used to regulate the speed of small motors and other electrical devices.



1852 LUXURY LINER

Just as a change in pace, don't you think it would be fun to go back in time 143 years ago? Light a candle, turn off the TV or radio, curl up in a warm place and concentrate. If you're good at it you can smell the sea, feel the ship bobbing up and down in the ocean swells, and maybe even get a little seasick.



OCEAN LIFE.

BY JOHN S. C. ABBOTT

Sat. Eve, March 20, 1852. Atlantic Ocean.

AT precisely seven minutes after 12 o'clock to-day, the steamer Arctic left New York for Liverpool. Our whole ship's company, passengers and crew, amounted to one hundred and eighty. The day was clear and cold. A strong north wind swept from the snow-clad hills over the rough bay. Icicles were pendent from the paddle-wheels, and the spray was freezing upon the decks. As the majestic steamship left the wharf, the crowd assembled there gave three cheers, and two guns were fired from on board. With the engines in active play, and our sails pressed by the fresh breeze, we passed rapidly down the narrows. No one can thus leave his home, to traverse weary leagues of land and sea, without emotion. Images of the loved, who may never be seen again, will rush upon the mind. And even if the most resolute retire for a moment to their state-rooms, throw themselves upon the sofa, bury their faces in the pillow, and, with a moistened eye, plead with God for a blessing upon those who are left behind, it is not to be condemned as a weakness. I soon returned to the deck. It was swept by a bleak wintry wind. There was not a single individual on board the ship whom I had ever seen before. Taking a stand in the shelter of the enormous smoke-pipe, so vast that twenty men could with perfect convenience cluster under its lee, we watched the receding shores. At half past three o'clock the gong summoned us to a sumptuous dinner. Again returning to the deck we watched the dim outline of the land until it disappeared beneath the horizon of the sea. At seven o'clock we were again summoned to the tea-table. Returning to the deck, we found dark and gloomy night brooding over the ocean. The wind, though piercingly cold, was fresh and fair. The stars shone brilliantly through black masses of clouds. Our ship rose and fell as it plowed its way over the majestic billows of the Atlantic. Retiring to the dining-saloon, which is brilliantly illuminated with carced lamps, I commenced this journal. And now

"Rocked in the cradle of the deep,
I lay me down in peace to sleep."

Sabbath Eve, Mar. 21. Lat. 43° 50'. Long. 65° 15'.

Miles made at noon 300. We have had truly a magnificent Sabbath day. The sky has been cloudless, the wind fresh and favorable. At 12 o'clock each day the captain takes an observation to decide our latitude and longitude, and the number of miles the ship has made during the last twenty-four hours. The sea is rough, and it is more comfortable, or, rather, less uncomfortable to be upon deck than in the saloons. Sheltered in some degree by the smoke-pipe, round which the wind is ever circling, I have passed the weary hours of the monotonous day, looking out upon the solitary ocean and the silent sky; both impressive emblems of eternity and infinity. Toward night the wind changed into the east, and blew more freshly. Clouds gathered. Angry waves, black and foaming, swept madly by. The solitude of stormy night upon the ocean! What pen can describe? And yet who can be insensible to the luxury of that solitude—to its melancholy sublimity! As I now write, our ship plunges and rolls in the heavy sea, and a deathlike nausea comes over me.

Monday Night, Mar. 22. Lat. 42° 23'. Long. 61° 23'.

Miles made 308. The malady of the sea drove me rather suddenly last night from my pen to the deck. But in an hour the clouds and the gust passed away. The stars came out in all their brilliance. The wind, however, has steadily increased, and it has been quite rough all day. Many are very sick, and nearly all are in a state of decided discomfort. There is an indescribable charm which the ocean has in its wide expanse, and in its solitude, and the imagination loves to revel in its wild scenes, but it is, even in its best estate, an uncomfortable place for the body to inhabit. Our most poetic descriptions of ocean life have been written in the enjoyment of warm and comfortable firesides on the land. Cushioned upon the parlor sofa, the idea is delightful, upon the ocean waves to be "borne like a bubble onward." But there is altogether too much prose in the reality. It is indeed "distance which lends enchantment to the view." Never did there float upon the ocean a more magnificent palace than that which now bears us. Our ship is two hundred and eighty-five feet in length, that is, nearly as long as four ordinary country churches. From the keel to the deck it is as high as a common five story house. Its width from the extremities of the paddle wheels is seventy-two feet, which is equal to length of most churches. The promenade deck, as we now sail, is as high above the water as the ridge-pole of an ordinary two story house. The dining-saloon is a large, airy, beautiful room, sixty-two feet long and thirty feet wide, with windows opening upon the ocean as pleasantly as those of any parlor, and where two hundred guests can dine luxuriously. The parlor or saloon is embellished in the very highest style of modern art. The walls are constructed of the most highly polished satin-wood, and rose-wood, and decorated with paintings of the coats of arms of the various States of the Union. Magnificent mirrors, stained glass, silver plate, costly carpets, marble centre tables and pier tables, luxurious sofas and arm-chairs, and a profusion

of rich gilding give an air of almost Oriental magnificence to a room one hundred feet in length and twenty-five feet in breadth. When this saloon is brilliantly lighted in the evening it is gorgeous in the extreme. The state-rooms are really *rooms*, provided with every comfort which can be desired. There are beds to accommodate two hundred passengers. Some of these rooms have large double beds with French bedsteads and rich curtains. There are nine cooks on board, whose united wages amount to over four thousand dollars a year. There is the head cook, and the second cook, and the baker, and the pastry cook, and the vegetable cook, &c. We have our butcher, our store-keeper, our porter, our steward. The ship's crew consists of one hundred and thirty-five men. There are four boilers, each heated by eight furnaces, and unitedly they consume eighty tons of coal a day. The two engines are of one thousand horse-power, and the weight of these enormous machines is eight hundred tons. Fifty-two men are constantly employed in their service. The ship carries about 3000 tons. From the waste steam 1500 gallons of pure soft water can be condensed each day. This wonderful floating palace, which is built as strongly as wood and iron can be put together, cost seven hundred thousand dollars. Even the ancients, endeavoring, with the imagination to form a craft worthy of Neptune, their god of the ocean, never conceived of a car so magnificent as this to be driven one thousand steeds in hand.

The United States have never yet done any thing which has contributed so much to their honor in Europe, as the construction of this Collins line of steamers. We have made a step in advance of the whole world. Nothing ever before floated equal to these ships. Their speed is in accordance with their magnificence. No one thinks of questioning their superiority. Every American abroad feels personally ennobled by them, and participates in his country's glory. There are four ships of this line, all of equal elegance—the Arctic, Baltic, Pacific, and Atlantic. It is not to be supposed that such ships should be immediately profitable to the owners. They were built for national glory. They do exalt and honor our nation. How much more glorious is such a triumph of humanity and art, than any celebrity attained by the horrors and the misery of war. The English government liberally patronizes the Cunard line of steamers. This line now needs the patronage of the government of the United States. We had far better sink half a dozen of our ships of war, important as they may be, than allow these ships to be withdrawn.

Tuesday Night, Mar. 23, Lat. 41°, Long. 55° 28'.

Miles made, 278. We are now about 300 miles south of Nova Scotia, yet in the "lee of the land," as one of our officers says. Toward morning we shall reach the western edge of the great bank of Newfoundland, which is about 200 miles broad. The wind is ahead, and the sea rolls in heavy billows. Our ship rises and plunges over these vast waves with much grandeur. It is majestically sickening, sublimely nauseating. The day is magnificent—clear, cloudless; and this fresh breeze upon the land would be highly invigorating. The ocean, in its solitude, spreads every where. We see no sails, no signs of life, except a few sea-fowl, skimming the cold and dreary waves. Though not absolutely sick, I am in that state that I must remain upon the wind and spray swept deck. We are now about a thousand miles from New York. On the whole, the discomfort of the voyage, thus far, has been less than I had anticipated. March is a cold and blustering month. We breakfast at eight o'clock, have an abundant lunch at twelve, dine at half-past three very sumptuously, take tea at seven, and those who wish it have supper at ten. The sun has gone down, the twilight has faded away, and night—cold, black, and stormy—has settled upon us. The wind is in the east, directly ahead; and, as we drive through it, it sweeps the deck with hurricane fury. I have been sitting upon deck, behind the smoke-pipe, around which the wind would most maliciously circle, till I was pierced through and through with the cold. Life upon the sea is indeed monotonous, as hour after hour, and day after day, lingers along, and you look out only upon the chill dreary expanse of wintry waves, and the silent or stormy sky. The sunset to-night was, however, magnificent in the extreme, and we made the most of it. As the sun sunk beneath the perfect horizon, it was expanded by the mist, and resembled one of the most magnificent domes of fire of which the imagination can conceive. We have the prospect of a stormy night. The saloon is brilliantly illumined, and ladies and gentlemen are reclining upon the sofas, some reading, but more pensively thinking of home and absent friends. The imagination in such hours will fondly run back to the fireside and the loved ones there. The voyager who has a home that is dear to him, pays a very high price for his enjoyments, he finds, in abandoning that home for the pleasures of the sea.

Wed. Morn., Mar. 24, Lat. 45° 30', Long. 49° 30'.

Miles made, 270. We have now been out four days, and are 1156 miles on our way. The sun rose this morning bright and glorious. A strong east wind sweeps the ocean. The enormous billows rush by, crested with foam. Our ship struggles manfully against the opposing waves. The *log* is thrown every two hours, to ascertain our speed. Notwithstanding the head wind, we are advancing nine miles an hour. The breeze wails most doleful requiems through our rigging. We are now upon the banks of Newfoundland. During the day our upper saloon has looked like an elegant parlor, spacious and luxurious. The sun has shone in brightly through the windows upon the carpet. Still the ship pitches so violently that it is with no little difficulty that one staggers from place to place. During many hours of the day, I stood upon the deck, watching the black and raging sea. As the sun went down in clouds, and the darkness of a stormy night came on, it became necessary to *house* the topmast. It was fearful to see the sailors clinging to the ropes as the ship rolled to and fro in these vast billows. Suddenly there was a loud outcry, and terrific groans came from the topmast. A poor sailor had somehow got his arm caught, and it was being crushed amidst the ponderous spars, far up in the dark and stormy sky. O! how dreadily those groans fell upon the ear. After some time he was extricated and helped down, and placed in the care of the surgeon. From this scene, so sad, so gloomy, I descended to the ladies' saloon. How great the transition! The gorgeous yet beautiful apartment was brilliant with light. Its ceiling richly carved and gilded, its walls of the most precious and highly polished woods, its mirrors, its luxurious furnishings, presented as cheerful a scene as the heart could crave. Taking a seat upon the sofa with one of the most accomplished and agreeable matrons I have ever met, I found the barometer of my spirits rapidly rising to the region of clear and fair. It was a happy hour. The dark sea, the storm, the night, all were forgotten, as in that beautiful saloon, in social converse, time flew on silken wings. It is now nearly eleven o'clock at night. I have just returned from the deck. It is sublimely gloomy there. We are pitching about so violently, that it is with the utmost difficulty that I write. Occasionally my inkstand takes a rapid slide across the table, when it is caught by a ledge, which prevents it from falling.

Thursday Night, Mar. 25. Lat. 47° 24', Long. 43° 35'.

Miles passed 267. A dull easterly wind is still rolling a heavy sea against us which much retards our progress. The day has been cold, cloudy, and wet. Sheets of mist are sweeping over the sombre and solitary ocean. It has been so cold, even in the saloons, which are warmed by steam-pipes, that it has been necessary to sit with an overcoat on. It is estimated that we are now just about in the middle of the Atlantic. It is 3055 miles from New York to Liverpool, by the route which the steamers take. The difference in time between the two cities is 4 hours 55 minutes. The wind to-night is high, and the ocean rough. But in our beautiful parlor we have passed a pleasant evening. Nearly all have now become so accustomed to the motion of the ship, as to be social and agreeable. We have Jews and Gentiles, Catholics and Protestants, on board, and all tongues are spoken. Our fellow-passengers are very pleasant and gentlemanly. Most of them appear to be clerks or younger partners in mercantile houses going out to make purchases. There is, however, an amazing fondness for champagne and tobacco. Were Byron here, he would, without doubt, correct his celebrated line, "Man, thou pendulum betwixt a smile and a tear," into, "Man, thou pendulum betwixt the wine glass and the cigar."

Friday Night, Mar. 26. Lat. 49° 26', Long. 39° 57'.

Miles made 263. The wind still continues in the east, strong and cold. Nothing has occurred all day to break the monotony of ocean life. We are so far north that we meet no ships, and nothing relieves the dreary expanse of the dark clouds above and the angry waves below. Our ship plows her way majestically through these hostile billows.

"The sea, the sea, the open sea,
The wide, the wild, the ever free."

"Oh!" said a gentleman this morning, as he looked out sadly upon the gloomy spectacle, "that is a fine song to sing *upon the land*." As our ship incessantly rises and plunges over these heavy swells, we become excessively weary of the ceaseless motion, even though no nausea is excited. One is often reminded of Madame de Stael's remark, that "traveling is the most painful of pleasures." Still, by reading a little, writing a little, talking a little, and thinking much, time passes quite rapidly. There are moments of exhilaration. There are hours of contentment. There are many hours of submissive endurance. Now and then there will come moments of sickness, and pain, and gloom, very nearly approaching to misery. It, is perhaps, not well to introduce the reader into these dark chambers of the soul. But, if unintroduced the untraveled can not know what life upon the ocean is. This evening we plunged quite suddenly into a dense fog-bank. No one can imagine a more desolate and dreary scene than the ocean now presents. The rain falls dripping upon the deck. The fog is so thick that you can see but a few feet before you. The stormy

wind directly ahead, wails through our moaning shrouds. The sky is black and threatening. The angry waves with impotent fury dash against the sides of the ship. The gloom without is delightfully contrasted with the cheerful scene within. The saloon is brilliantly illuminated. Groups of ladies and gentlemen are gathered upon the sofas, some reading, some talking, some playing various games.

Saturday Night, Mar. 27. Lat. 50° 56'. Long. 30° 51'.

Miles passed 286. We are now 1962 miles from New York. We have been out just one week, and, for five days, we have had a strong head wind. To-day the wind has increased into a violent storm. The decks are swept with rain and spray. The ocean is white with foam. Our ship, enormous as it is, is tossed, like a bubble, upon these raging billows. You start to cross the saloon; a wave lifts the stern of the ship some twenty feet into the air, and you find yourself pitching down a steep hill. You lean back as far as possible to preserve your balance, when suddenly another wave, with gigantic violence, thrusts up the bows of the ship, and you have a precipitous eminence before you. Just as you are recovering from your astonishment, the ship takes a lurch, and, to your utter confusion, you find yourself floundering in a lady's lap, who happens to be reading upon a sofa on one side of the saloon. Hardly have you commenced your apology ere another wave comes kindly to your rescue, and pitches you bodily out of the door. It is with the utmost difficulty that I write. I have, however, contrived to block up my inkstand with books, and, by clinging to the table, succeed in making these hieroglyphics, which I fear that the printer will hardly be able to read. Many are very sick and very miserable. I am in a state of submissive endurance. The reader, however, may be fully assured, that there are many positions far more agreeable than to be on the middle of the Atlantic ocean in a wet, easterly storm. Our noble ship is so magnificently strong, that we have no more sense of danger than when upon the land. There is something in this nausea, which seems to paralyze all one's mental energies. Never before have I found such an effort of *will* requisite to make any mental exertions. There was a portion of the evening, however, notwithstanding all these discomforts, passed very pleasantly away. In the boudoir-like magnificence of the ladies' saloon, with our excellent captain, and a few intelligent and pleasant companions, gentlemen and ladies, we almost forgot, for an hour, the storm and the gloom without, and conversed with just as much joyousness as if we had been in the most luxurious parlor on the land. These saloons, brilliantly lighted with carcel lamps, look far more gorgeous and imposing by night than by day. It is now eleven o'clock at night. Every other moment an enormous billow lifts us high into the air, and then we go down, down, down, exciting that peculiar sensation which I remember often to have had in my dreams, when a child. The scene from the deck is truly sublime. The howling of the tempest, the rush of the waves, the roar of the sea, the blackness of the night, the reflection that we are more than a thousand miles from any land, floating like a bubble upon the vast waves, all combine to invest this midnight hour upon the ocean with sublimity. The waves to-night will rock us to sleep, while the winds wail our mournful lullaby.

Sabbath Night, Mar. 28. Lat. 51°. Long. 25° 7'.

Miles made 219. Last night our easterly storm increased to a gale, and blew with hurricane fury. It was utterly impossible to sleep, we were all so rudely jostled in our berths. The motion of the ship was so great that we were in constant danger of being rolled from our beds upon the floor. Every timber in the iron-bound ship creaked and groaned, and occasionally a sea would strike our bows, which would make the whole fabric shiver. It was, indeed, an exercise in gymnastics to perform one's toilet this morning. Every thing which was not a fixture was rolling hither and thither. It was utterly impossible to stand for a single moment, without catching hold of something for support. The ship now keeling in one direction, now in another; at one time rising ten or fifteen feet into the air, and again as suddenly sinking; now, apparently stopping, as struck by a heavy sea, and again plunging forward with the most sullen and determined resolution, presented a series of movements which defied all calculations. Early in the morning I clambered upon deck, and leaning against the mast, and clinging to the ropes, looked out upon the wild, wild scene. The roar of the gale through our shrouds was almost terrific. It seemed like the voice of an angry God. But five persons sat down at the breakfast-table at the usual hour. It was, indeed, a curiosity to see the waiters attempt to move about upon the unstable footing of our floor. One would take a cup of coffee, and, clinging to the side of the cabin, and carefully watching his opportunity, would dart toward a pillar, to which he would cling, until he was prepared to take another start. But with all his precautions, he would frequently be thrown upon one of the cushioned seats of the dining-room, and the liquid contents of his dishes would be any where. A gentleman would attempt to raise a cup of tea to his lips. Alas! there is many a slip. A sudden lurch of the ship ejects the hot beverage into his bosom instead of his mouth. It is almost dangerous to attempt to move about, you are thrown to and fro with so much violence. Every thing is made fast which can be secured. It is a wild scene of uproar and confusion, and I have no desire again to witness a storm at sea. Nausea sadly detracts from all conceptions of the sublime. Very many are sick. I am very far from feeling comfortable. As I look around me upon this tumultuous scene, listening to the uproar of the elements, I feel how utterly impossible it is for the pen to communicate to the distant reader any idea of this midnight ocean-storm. By clinging to the table, so as to become, as it were, a part of it, I succeed, with much difficulty, in writing. The wind seems still to be rising as we advance into the hours of the night, and the ship struggles and plunges more and more violently. We have had a dismal, dismal day. There is no comfort any where. One can neither walk, nor stand, nor sit, nor lie. I have spent many hours of the day wrapped in my cloak, shivering upon the bleak and storm-swept deck. And now I dread to return to my state-room, for there can be no sleep upon these angry billows. The head aches, the stomach remonstrates. As the night, black and stormy, settled down upon the cold, bleak, wet deck, I thought of home, of the pleasant songs of our Sabbath evening, of those lines, written by a sainted one, and ever sung in the peaceful twilight of the Lord's day:

> "'Tis Sabbath eve and all is still,
> Hushed is the passing throng,
> Oh, Lord, our hearts with praises fill
> And tune our lips to song."

I hummed the familiar tune, in the midst of the dirges of the ocean. And as memories of the past came rushing over me the subdued spirit vanquished the sternness of manhood. Who can not sympathize with the childish emotions of the pilgrim of three score years and ten, as he loved to place his gray hairs upon his pillow, and to repeat the infant prayer his mother taught him:

> "Now I lay me down to sleep,
> I pray the Lord my soul to keep,
> If I should die before I wake,
> I pray the Lord my soul to take."

Monday Night, Mar. 29. Lat. 50° 52'. Long. 19° 25'.

Miles made 209. Toward morning the wind abated and *backed* round into the north, and with a clear sky and a fresh breeze, we bounded over the agitated ocean. About two o'clock, however, the wind returned again to the east, and dim masses of clouds were rolled up into the sky. The barometer rapidly fell, and we were threatened with another gale. The sea was rising, the rain beginning to fall, and the ship was rolling and pitching, each moment more heavily, in the waves. We plunged suddenly into a dense fog bank, and prepared for a dreary and stormy afternoon and night. But after two or three hours of cold, and wet and dismal sailing, we suddenly emerged from the fog bank, and came out into pleasant weather on the other side. The moon shone out resplendently. Just as the evening twilight was fading away we descried, far off in the northern horizon, a large steamship, undoubtedly the Africa, which left Liverpool yesterday. Two signal rockets were thrown up from our ship, but they were probably not seen, as we obtained no response. I was quite amused with a little incident which occurred this evening. A large party of gentlemen were clustered upon the deck, talking together. A ship was dimly discerned in the distance. A gentleman looked through the telescope at the faint speck in the horizon, and very confidently said, "It is an English ship." "How can you tell?" another inquired. "Because," he replied, "she has so little sail set. An American captain would have every sheet spread in such a wind as this." Some doubt was expressed whether one could thus accurately judge. "Ask the captain," said he, "whether that is an English or an American ship." The captain was at some distance from us, and had not heard our conversation. He had, however, silently examined the ship with his glass. "Captain," one called out, "what ship is that?" "It is an English ship," he quietly replied. "How can you tell?" was immediately asked. "Because," he answered, "she has so little sail spread. No Yankee would be creeping along at that pace in this breeze." It was afterward stated that the English captains are paid only while their ships are at sea, and that the payment is quite small. They are therefore rather under the inducement to make long voyages. The Americans, on the contrary, are paid while the ship is in port, and they drive their voyages with the utmost speed. Whether there be any foundation for this opinion, I know not. The incident however was quite interesting.

Tuesday Night, Mar. 30. Lat. 50° 53'. Long. 11° 54'.

Miles made 219. The captain informed us that we were 95 miles from Cape Clear at noon to-day, and that we might expect to see the coast of Ireland about six o'clock. The day has been magnificently beautiful. We have seen many ships in the horizon, indicating that we

were leaving the solitudes of the ocean behind us. Immediately after dinner all the passengers assembled upon deck to catch the first glimpse of land. At just a quarter before six o'clock we saw the highlands of the Irish coast looming through the haze before us. No one who has not crossed the ocean can conceive of the joyous excitement of the scene. All the discomfort of ocean life was forgotten in the exhilaration of the hour. As twilight faded away, the outline of the shore became more visible under the rays of a most brilliant moon. Soon the light from Cape Clear beamed brilliantly before us. It is now half-past ten o'clock at night, and the night is clear, serene, and gorgeously beautiful. The dim outline of the Irish coast looks dark and solitary. Upon those gloomy headlands, and in those sombre valleys what scenes of joy and woe have transpired during centuries which have lingered away. We are rapidly sailing up the channel, having still some two hundred and fifty miles to make, before we land in Liverpool. But our ocean life is ended. We have crossed the Atlantic. At seven o'clock to-morrow evening we expect to leave the ship.

Wednesday Night, March 31. Waterloo House, Liverpool, 12 o'clock.

This last day, much to my surprise, has been one of the most cheerless and disagreeable days of our whole voyage. A chilling east wind has swept the cold and foggy ocean. The decks were wet and slippery. Drops of water were falling upon us from the drenched shrouds. Nothing could be seen but the dense mist around us, and the foamy track of our majestic steamer. It was a great annoyance to think that, were the sky clear, we might be almost enchanted by the view of the green hills and the cottages of England. For a few moments, about noon, we caught a glimpse, through the sheet of mist sweeping the ocean, of the coast of Wales, but in a few moments the vail was again drawn over it, and wailing winds and rain and gloom again enveloped us. At about six o'clock in the evening we discerned, through the fog the steeples and the docks of Liverpool. The whole aspect of the scene was too dingy, wet, and sombre for either beauty or sublimity. We were long delayed in our attempts to get into the dock, and finally had to relinquish our endeavor for the night, and to cast anchor in the middle of the river. About half-past seven o'clock a small steamer came on board bringing several custom-house officers. All our trunks were placed in the dining-saloon in a row, and the officers employed three tedious hours in searching our trunks for contraband goods. Faithfully they did their duty. Every thing was examined. Many of our passengers were much annoyed and complained bitterly. I saw however, no disposition whatever, on the part of the custom-house, to cause any needless trouble. So far as I could judge they performed an unpleasant duty faithfully, and with as much courtesy as the nature of the case would allow. There is a very heavy duty imposed upon tobacco and cigars. There is a strong disposition to smuggle both of these articles into the kingdom. If it is understood that writing desks are not to be unlocked, and that packages are not to be opened, and that the mere word of any stranger is to be taken, the law at once sinks into contempt. The long delay was tedious, very tedious; but the fault was ours. Had every man honestly, so arranged his trunk, as to show at once what was *dutyable*, the work might have been accomplished in one-third of the time. At eleven o'clock by a long step-ladder, we descended the sides of the ship to a little steamer, and were landed in the darkness of the fog upon the wet docks. Taking hacks, nearly all of our passengers soon found themselves in more comfortable quarters at the Waterloo Hotel. It is now midnight. Most of my companions are mirthfully assembled around the supper table. If songs and laughter constitute enjoyment, they are happy. I, in enjoyment more congenial with my feelings, am alone in my comfortable little chamber, in an English Inn, penning these last lines of our ocean life. But I can not close without a tribute of respect and gratitude to our most worthy commander, Capt. Luce. By his social qualities, and his untiring vigilance, he won the esteem of all in the ship. Our shipmates were friendly and courteous, and though of sundry nations, and creeds, and tongues, dwelt together in singular harmony.

Reader, forgive me for the apparent egotism of this journal. I have wished to give the thousands in our country who have never traversed the ocean, an idea of ocean life. I could not do so, but by giving free utterance to the emotions which the varied scenes excited in my own heart. I have only to add, that if you ever wish to cross the Atlantic, you will find in the Arctic one of the noblest of ships, and in Capt. Luce one of the best of commanders.

Chemicals You Can Make in Your Home Laboratory

POPULAR SCIENCE MONTHLY FEBRUARY, 1933

Acids and Alkalies Easily Combine to Form New Substances You Can Use in Experiments

By RAYMOND B. WAILES

MAKING MAGIC SMOKE WITH YOUR HANDS
If the dampened stoppers from bottles of ammonia water and muriatic acid are brought together, thick white fumes will rise first from the acid stopper and then from the ammonia stopper. If the palm of one hand is moistened with muriatic acid and the palm of the other with ammonia water, smoke will rise when hands are brought together as shown at left

BY EXPERIMENTING with acids and alkalies, the amateur chemist can make many of the chemicals he uses in his home laboratory. In this way, simple reactions, that require little equipment, become profitable, interesting, and instructive.

When an acid and a base combine in the right proportions, a new substance is formed. Sal ammoniac, for instance, can be made by holding an unstoppered bottle of ammonium hydroxide (household ammonia will do) next to the open mouth of a hydrochloric (muriatic) acid bottle. The sal ammoniac appears as a dense white cloud that will float in the air and eventually disappear.

This novel reaction forms the basis of an interesting experiment that can be added to the amateur magician's bag of tricks. Wet the stopper of the muriatic acid bottle, by shaking the bottle, and touch the moist stopper to the palm of the right hand. This will place a harmless amount of acid on the skin. Do likewise

with the moist stopper of the household ammonia bottle, placing a small amount in the palm of the left hand.

To the casual observer, both hands will appear empty. However, when they are cupped together and the two thumbs placed to form an exit hole, dense clouds of white fumes will pour out. To prove your hands are empty you can move them apart only to place them together again and produce more of the mystifying sal ammoniac smoke.

Similarly, two apparently empty glasses—one containing a drop of ammonia water and the other a drop of muriatic acid—will smoke when they are placed together.

In combining, the acid and the base in each case neutralize each other to form a new substance—sal ammoniac (ammonium chloride). Chemists call this reaction neutralization and make use of it as a test for computing the relative strengths of chemicals as well as a means of producing other chemicals.

Neutralization can be demonstrated in the home laboratory with the aid of an indicator such as an alcohol solution of phenolphthalein obtainable at any drug store.

First make up a limewater solution by dissolving lime in water. Shake it vigorously for several minutes and allow it to settle. Then carefully pour off the clear upper liquid.

Next place one drop of muriatic acid in a beaker and to this add some water and a drop of the phenolphthalein solution. Then with a medicine dropper, slowly add the limewater to the acid solution in the beaker, counting each drop as it falls and stirring the acid continually. Add the limewater in this way until a single drop colors the liquid red. When the red color remains for at least a quarter of a minute it indicates that enough limewater has been added to neutralize the acid.

You will probably find that about 240 drops of the limewater will be needed to neutralize the single drop of muriatic acid. By repeating the test with other bases, their strengths can be compared.

In a similar manner, a weak lye solution made by dissolving several pea-size pieces of lye in a half pint of water can be used for comparing the relative strengths of vinegars (acetic acid). The stronger the vinegar, the greater will be the amount of lye water needed to neutralize it. Of course, it is important that the same quantity of vinegar be used in each test and that the lye water be of uniform strength.

Tests of this sort are referred to by the industrial chemist as *titrations* and a special measuring tube used to drop the one liquid into the other is called a *burette*. Commercial burettes are expensive but the home experimenter can make a good substitute from several feet of half inch diameter glass tubing, a medicine dropper, some rubber tube, and a spring clothespin as shown in the photograph on this page.

GRINDING A GLASS STOPPER

Valve grinding compound is put on the glass stopper and it is then twisted back and forth inside the neck of the bottle to wear it to proper size. It must also be pushed in and out to keep it perfectly round

Common Substances That Can Be Used in the Home Laboratory

COMMON NAME	CHEMICAL NAME
Alum	*Potassium aluminum sulphate*
Bleaching powder	*Calcium hypochlorite*
Boracic acid	*Boric acid*
Borax	*Sodium tetraborate*
Calomel	*Mercurous chloride*
Chalk	*Calcium carbonate*
Copperas	*Ferrous (iron) sulphate*
Cream of tartar	*Potassium bitartrate*
Epsom salt	*Magnesium sulphate*
Glauber's salt	*Sodium sulphate*
Limewater	*Calcium hydroxide solution*
Lye	*Sodium hydroxide*
Quicklime	*Calcium oxide*
Rochelle salt	*Sodium potassium tartrate*
Sal ammoniac	*Ammonium chloride*
Sal soda	*Sodium carbonate*
Salt	*Sodium chloride*
Washing soda	*Sodium carbonate*
Water glass	*Sodium silicate solution*

THE long glass tube is fitted with a stopper through which projects the end of a small glass tube. The glass portion of a medicine dropper is connected to this projecting tube by means of the short length of pliable rubber tubing. The spring clothespin, placed over the rubber tubing as indicated, serves as a valve for controlling the flow of liquid from the tube.

On commercial burettes, divisions etched on the long glass tube tell how much of the liquid is used in each titration. With the homemade burette, the amateur chemist can obtain a similar result by keeping an accurate count of the drops falling from the tip. If desired, an olive bottle with its bottom removed can be substituted for the large diameter glass tubing.

By neutralizing sodium hydroxide (lye water) with dilute sulphuric acid, the home chemist can make sodium sulphate. Place the acid in a beaker or other convenient glass container and add a drop or two of the phenolphthalein solution. Fill your homemade burette with the weak lye solution and adjust the clothespin so that the solution drops slowly into the beaker.

As before, when one drop of the alkali (base) turns the solution red, neutralization is complete and the beaker will contain sodium sulphate in solution. The solid sodium sulphate can be obtained by heating the solution until all the water has been driven off. This can be done by boiling the solution until only a few ounces are left and placing the remainder on a water or steam bath as described last month. When all the water has been evaporated, white sodium sulphate remains and this can be bottled and labeled.

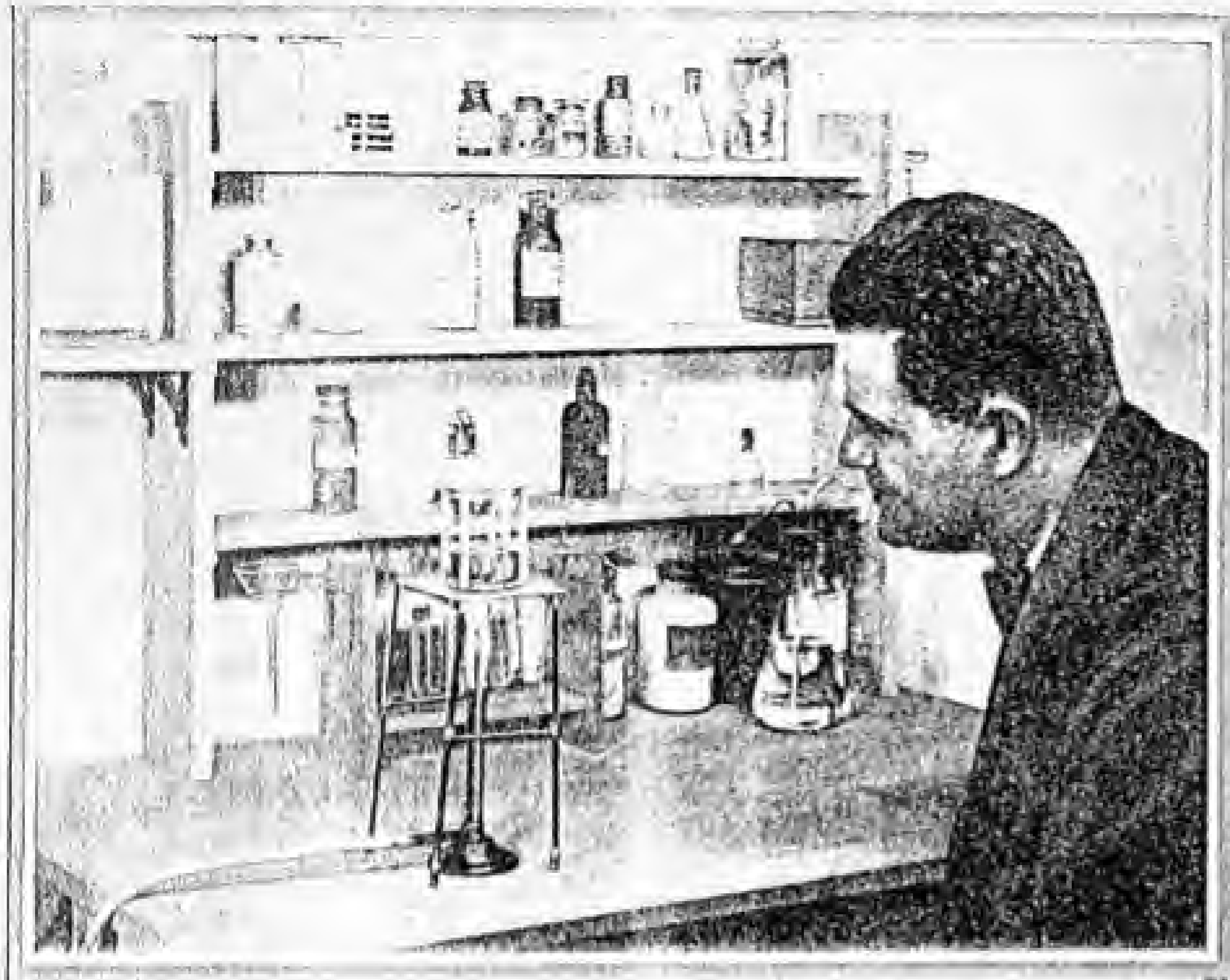
Neutralization produces heat. If the solution becomes too hot during the above process, add a little water to the beaker.

Acids and bases also can be made to react with salts to form other chemicals for use in the amateur's laboratory. Epsom salts, chemically known as magnesium sulphate, can be used in making several magnesium compounds.

MAKE a solution of Epsom salts in water, place it in a beaker, and to it add lye water. A white precipitate will be formed. Allow the beaker to stand for some time and you will notice that the white precipitate settles to the bottom.

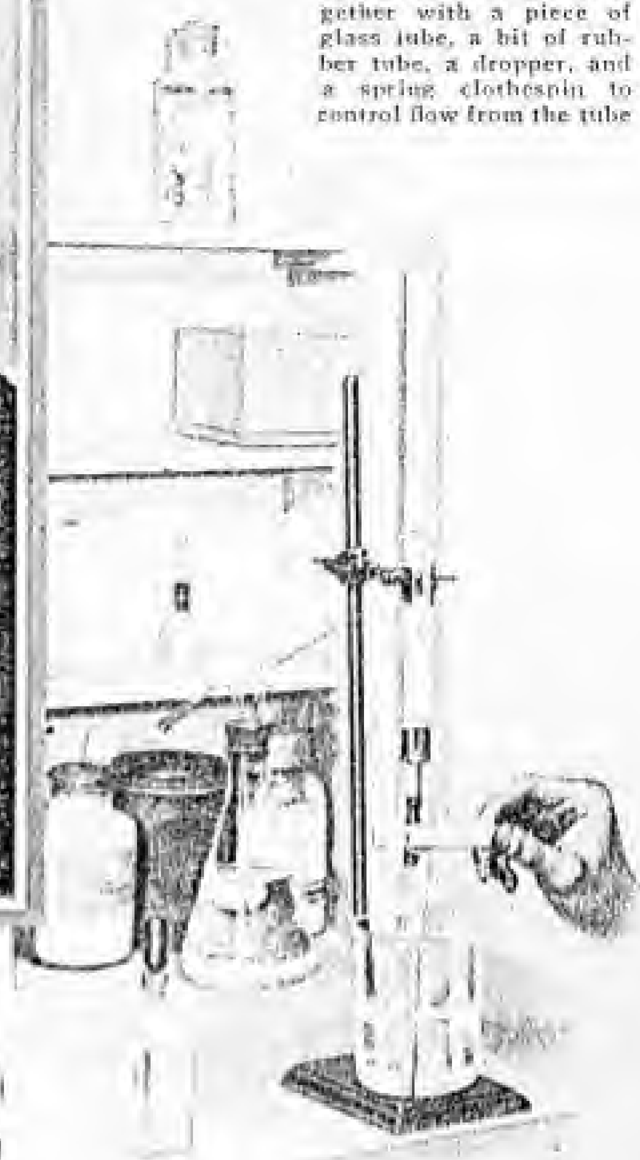
When it has completely settled, add one or two more drops of the lye water. If more precipitate is formed, add more lye water and again wait for the precipitate to settle. Test the clear liquid with a few drops of lye water as before and repeat the process until no precipitate is formed.

The white substance resting on the bottom of the beaker will be magnesium hydroxide. Pour off the liquid, add clear water, shake it, and again pour off the liquid. Repeat this several times to wash the magnesium hydroxide thoroughly. After several such washings, test for the presence of lye water in the clear wash liquid by using litmus paper or phenolphthalein solution. Red litmus will turn blue and the colorless phenolphthalein solution will turn red if the slightest trace of lye water remains. If necessary, further



The chemical made by neutralization can be recovered by use of the steam bath as shown above. The liquid is evaporated by the heat from the beaker and the precipitate is left

Below is shown a homemade burette, put together with a piece of glass tube, a bit of rubber tube, a dropper, and a spring clothespin to control flow from the tube



washings will remove every trace of the caustic.

PLACE the precipitate in an evaporating dish and remove the water that remains by placing it on a water bath. Then heat the dish until the precipitate is dry. The heat changes the original magnesium hydroxide into magnesium oxide or magnesia. If this is dissolved in muriatic (hydrocholoric) acid, magnesium chloride will be formed. The solid magnesium chloride can be obtained for bottling through the use of a water bath.

When dissolving the magnesium oxide in the acid, use more of the oxide than the acid. In this way, not all of the oxide will be attacked. Filter and then evaporate the water. This will prevent the final product from being contaminated with the acid.

If the magnesium oxide is dissolved in nitric acid, magnesium nitrate will be formed. If it is dissolved in sulphuric acid, magnesium
sulphate or Epsom salts—the same substance used in the beginning—will result.

Many chemicals can be made by immersing a metal in a chemical solution. An iron nail placed in a solution of copper sulphate will become plated with copper. If allowed to remain in the solution for several weeks, all of the copper can be obtained from the solution in the form of a brown powder. The solution, when filtered, contains iron sulphate and can be used as such.

Similar processes in the same way produce other chemicals. The novel lead tree described in a recent issue (P.S.M., Dec. '32, p. 59) yields lead crystals and zinc acetate. Incidentally, lead trees can be preserved as a curiosity by placing a layer of oil on the surface of the liquid to prevent evaporation and exclude the air.

Dry chemicals as well as liquids often tend to form new substances. If some powdered lead nitrate crystals, which are white, are mixed with potassium iodide powder, which is white, yellow lead iodide powder is formed. Thorough mixing of the two chemicals can be obtained by placing them in a pill box or stoppered bottle and shaking them vigorously.

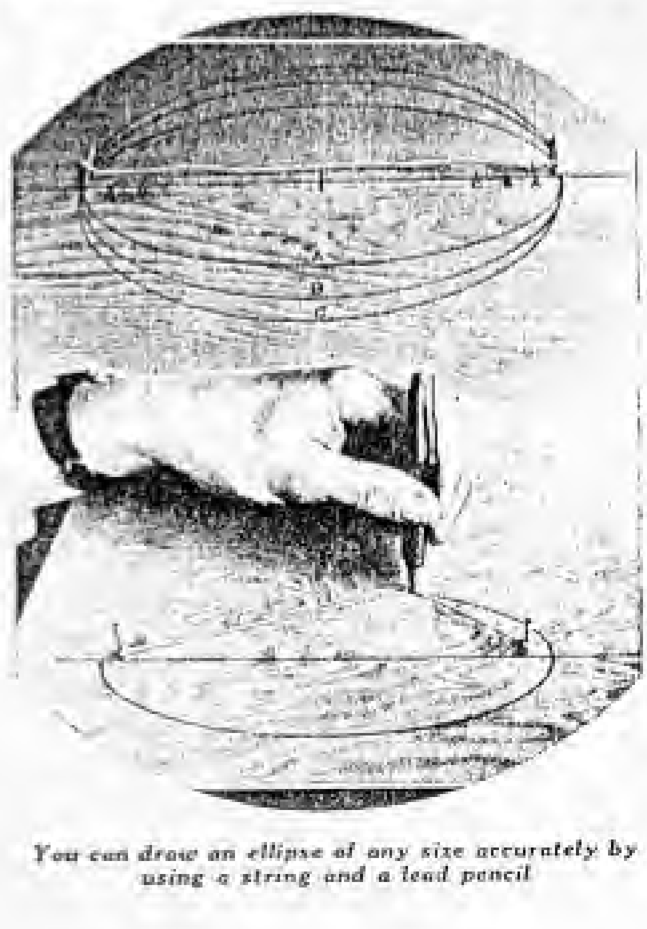
When stocking the home laboratory with chemicals, acids should be kept in glass stoppered bottles. With the exception of ammonia water, which should preferably be stored in glass stoppered bottles, most alkalies in solution may be stored in bottles having rubber corks.

If ordinary corks must be used and they are attacked by the chemicals, coat them lightly with hot wax. Glass stoppers that do not fit their bottles snugly can be ground to a perfect fit by placing valve grinding compound on the stopper, inserting it in the bottle neck, and twisting it back and forth and moving it up and down. The compound will wear both surfaces to make a perfect fit.

Many common household substances found in the kitchen and on the medicine shelf can be used by the amateur in his home laboratory. Baking soda, for instance, is chemically known as sodium bicarbonate and can be used as such.

Ellipse Drawn with Aid of Cord

A length of hard, braided cord, two pins and a pencil is all the equipment you need for laying out an accurate ellipse of almost any size. First, lay off the center line on



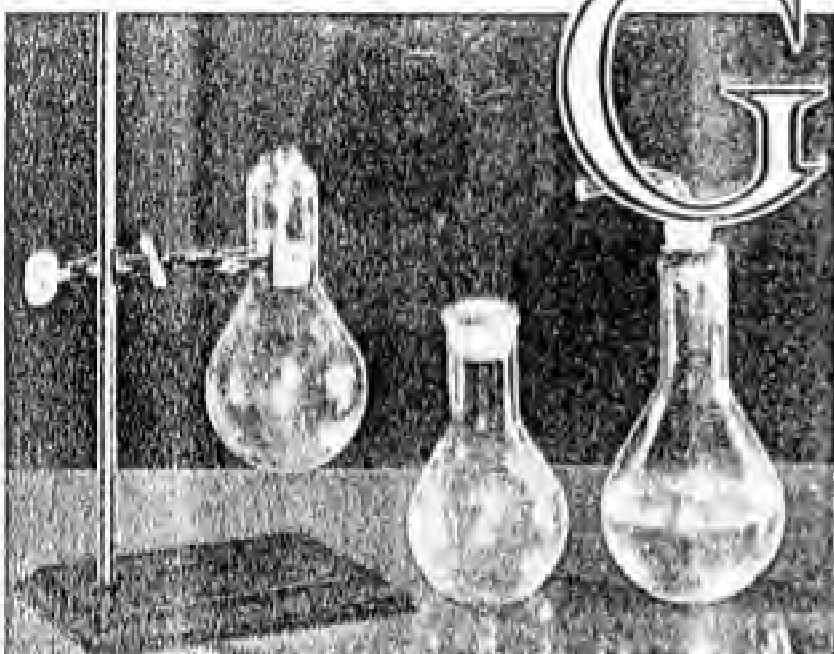
You can draw an ellipse of any size accurately by using a string and a lead pencil

POPULAR SCIENCE MONTHLY NOVEMBER, 1933

HOW TO CONVERT OLD ELECTRIC LIGHT BULBS INTO *Chemical Glassware*

By Earl D. Hay

Above: Holding bulb with cloth while enlarging the mouth. *Below:* Filing the threads of a brass cap so it can be stripped away



Three of the simpler types of flasks made by the author from burned-out bulbs. Long-necked flasks and distilling flasks are also easy to make after a little practice

EXPERIMENTS in an amateur chemical laboratory are much more interesting when they are made with the same kind of apparatus as that used in professional laboratories. As a rule, however, the home chemist experiences a great shortage of flasks and endeavors to use various kinds of bottles as makeshifts, little realizing that he may make from burned-out electric light bulbs a great variety of useful flasks like those sold by chemical supply houses at from 20 to 75 cents each.

The lamps used in the average home vary in size from 25 to 200 watts and are suitable for small Florence or boiling flasks. Larger flasks are made from 300-, 500-, and 1,000-watt lamps, which can be obtained from the janitors of stores and linemen of the city lighting companies.

The methods of working all sizes are the same, and only a few minutes are required to complete a flask.

The method of making a Florence flask washing bottle from a 300- or 500-watt lamp will be described. The flat bottom is made first. Cut off the connection of the center wire on the cap with a knife and break off the end of the slender tube which was used in evacuating the bulb when it was made. This is necessary in order to equalize the air pressure on both sides of the glass wall. Next screw the light into a drop-cord socket to provide a handle for holding the bulb while the large end is being heated over a large laboratory gas burner or a gasoline blowtorch.

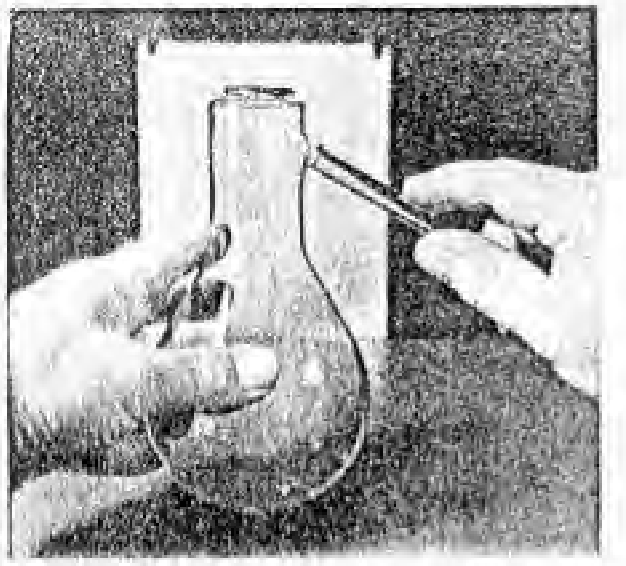
The bottom of the bulb is carefully warmed up and then heated evenly to a light red color. Now quickly place it in a vertical position on a level wooden block or an asbestos pad and bear down gently. The spherical bulb will flatten on the bottom. If heated too hot, the bulb will wrinkle and become distorted; if not heated enough, too much pressure will be required and the bulb will be broken.

After the bulb has cooled sufficiently to be handled, remove the brass cap from the neck by filing through the threads on a diagonal line as shown in one of the photographs in order not to scratch the glass with the file. Pull the split cap off with a pair of pliers, and scrape off the sealing wax that lies between the brass cap and the glass, taking care not to destroy the two copper wires leading into the center of the bulb.

As the bulb becomes quite hot while the neck is being shaped, it is necessary to provide some adequate means of holding it. If a pair of heavy asbestos mittens are not at hand, a satisfactory holder can be made from a piece of strong cloth by cutting a round hole in it large enough to admit the neck of the bulb. The neck is inserted through the hole, and the cloth folded back over the bulb.

The end of the bulb neck is now carefully heated until the glass becomes red and plastic. With a pair of pliers, seize the two copper wires and carefully remove the glass core by pulling straight out on the wires as the bulb is rotated in the flame to keep the entire circumference at the same temperature.

Next take a round, soft pine stick with a conical point and begin to open up the mouth of the neck and roll a bead on it by rotating the neck in the gas flame and rubbing the plastic edge out and down with the wooden stick. This en-



In making a distilling flask, a small hole is punched through the neck from the inside and a slightly flanged tube of glass is welded on

forging process is continued until the neck will take the desired size of cork or rubber stopper.

The flask is now complete and ready for use. If it is to be used for a washing bottle, a heavy rubber band or stout cord wound around the neck will make it much stronger in resisting the stopper pressure and more convenient to handle.

If the bulb is to be made into a boiling or a receiving flask, the bottom will not need to be flattened, and the brass top may be removed and the throat enlarged to the proper size at once. If a heavy smooth lip is desired, it can be made by making a mold of some heat-resisting material as shown in the drawings at the end of this article, and the lip turned down against it. This mold or form must be made in halves and clamped around the neck of the bulb. It must be warmed carefully before use, otherwise the glass will crack.

If a lipless flask is desired, the small end may be removed by placing a string saturated with kerosene around the neck and allowing it to burn away, then quickly plunging the neck into water up to the heated ring. This will cause the glass to contract and pop off at the line where it was heated. The broken edge is then smoothed by carefully grinding it down on a smooth grinding wheel and finishing it with a fine sharpening stone.

If a glass-tube cutter is available, the end of the neck can be removed without difficulty. This method is more reliable than the use of the kerosene string.

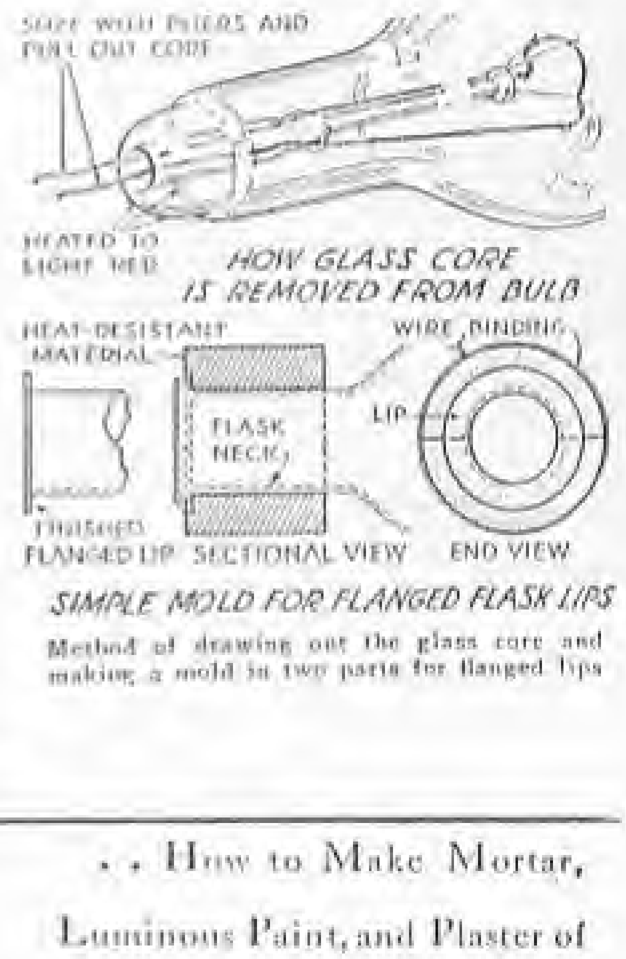
Long-necked flasks may be made by welding test tubes or necks from broken flasks to the necks of light bulbs. After a little practice this can be accomplished without difficulty. First be sure the ends to be joined are of the same diameter and fit all way around. This can be accomplished by grinding the ends on a smooth oilstone. Heat the ends carefully and evenly in the gas flame until plastic; then bring them into contact and exert a slight pressure.

FOR A DISTILLING flask, it will be necessary to weld a tube to the neck of one of the larger flasks at a downward angle of approximately 75 deg. to the neck. A hole is first made about halfway down the neck of the flask by heating the side of the neck to a red heat over the gas burner and then punching the hole from the inside by using a rolled wire with a right-angled hook on the end.

A piece of tube of the desired bore and length should be selected, and the free end heated sufficiently to smooth off the sharp edges. The end to be welded to the flask is next heated and flanged. This flange is turned out at a right angle to the tube and should extend about 1/8 in. all the way around it. The neck of the flask and the tube are next brought to a welding heat in the same flame; then the tube is carefully centered over the hole in the flask and the two gently pressed together. Very little pressure can be used or the flask will become distorted. The joint is now heated quite hot and the flange gently smoothed down to make the joint stronger and neater in appearance. In doing this, be careful to support both tube and flask or they will tend to sag out of shape.

AFTER the joint has been completed, the hot flask should be placed in a heated oven and allowed to cool very slowly. This will temper the glass and remove the strains set up in the welding operation. If all the flasks are given the hot-oven cure, they will be less liable to crack in use, especially when heated over a gas flame.

Sometimes the necks are cracked because of careless heating. If carefully cut off, the lower halves of such bulbs make transparent covers and shallow dishes.



SIMPLE MOLD FOR FLANGED FLASK LIPS

Method of drawing out the glass core and making a mold in two parts for flanged lips

Home Tests *with* Calcium Explain Industrial Processes

. . How to Make Mortar, Luminous Paint, and Plaster of Paris in Your Own Laboratory

POPULAR SCIENCE MONTHLY

DECEMBER, 1933

BY RAYMOND B. WAILES

WHAT makes mortar harden? Why does soap sometimes fail to lather? What is plaster of Paris and how is luminous paint made? These are only a few of the questions that are answered for you when you experiment with calcium.

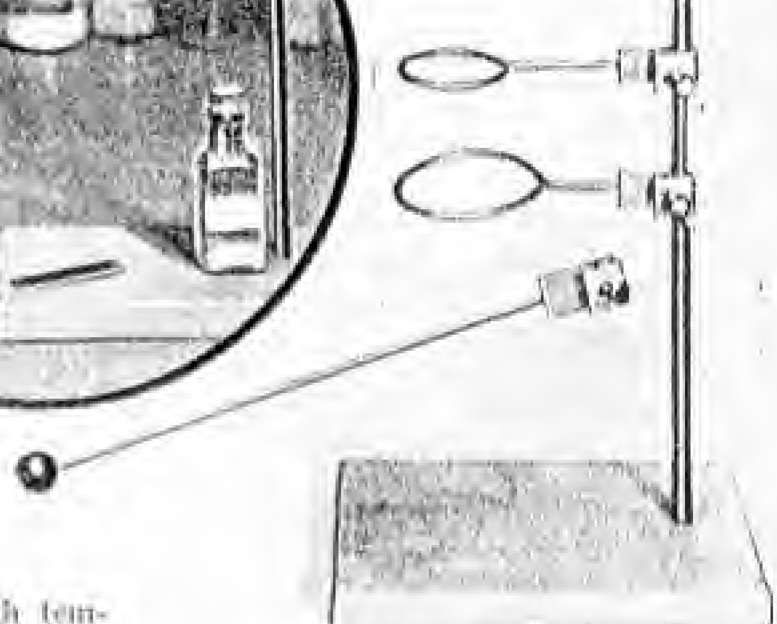
Although calcium in its free metallic form is not common, its many compounds are known to us all. Marble is a combination of calcium and carbon, glass contains calcium combined with oxygen, and in the building trades we find calcium in cements and mortars. Even the bones in our bodies contain a form of this interesting and important chemical.

In the case of mortar, the compound of calcium is derived from lime (calcium oxide) made from a natural product called limestone. As an introduction to calcium, you can make some lime in your home laboratory by heating marble chips (calcium carbonate). Place the chips in a porcelain crucible supported over a gas burner. The heat will drive off the carbon-dioxide gas in the marble and lime, or calcium oxide, will be left behind. This is called quicklime.

By adding water to the lime, you can change it to calcium hydroxide, or slaked lime. This mildly basic substance is sometimes referred to as milk of lime while the clear calcium-hydroxide solution is known as lime water.

You also can prepare small amounts of lime by heating oyster shells or eggshells. In your experiments with lime you can test its basidity by dipping red litmus paper into the water solution and noting if it turns blue.

After alcohol has been mixed with a calcium-acetate solution, a solidified alcohol results which, as is shown above, will not fall from the inverted beaker. When this jellylike substance is placed on a pan, as at right, and ignited with a match, it burns



Automobile fender guides, like the one shown above, can be bent around pipes of different diameters, to make rings of various sizes which, when attached to an upright, will hold funnels, beakers, or flasks

When lime is mixed to a paste and sand is added, mortar results. The hardening of mortar is merely a reversal of the process used to produce it. In making the original lime, solid calcium carbonate is heated to drive off the carbon-dioxide gas. In setting, the carbon dioxide slowly returns to the lime (calcium oxide) and reconverts it into calcium carbonate.

This changing back to its original state, however, often requires many years. Although mortar may be hard to the touch the day after it is laid, actually it requires some ten or twenty years completely to change to its solid state.

Plaster of Paris, another compound familiar to the building trade, also depends on the property of a calcium compound in setting. It is made by heating calcium sulphate, known in its natural state as gypsum, to a temperature slightly higher than that of boiling water. This heating drives off the moisture. When the resulting powder is mixed with water, it hardens in a very short time, the water uniting with the calcium sulphate to form hard hydrated calcium sulphate.

If plaster of Paris is heated to a higher temperature, its time of setting can be lengthened. The home chemist can demonstrate this by comparing the setting time of ordinary plaster of Paris and plaster of Paris heated to a high temperature over a gas burner in a crucible or the friction top of a tin can. Plaster of this type is said to be "dead burned."

BY COMBINING calcium with sulphur, the amateur chemist can make a mysterious luminous substance. After being exposed for a short period to a bright light, it will continue to glow when it is viewed in the dark.

The calcium for this experiment can be obtained from oyster shells. First heat the shells in a small porcelain or clay crucible over a burner and discard the darker portions of the cold residue. Then after powdering the lighter chunks, mix them with about twice their volume of flowers of sulphur, and place the mixture in a small porcelain crucible having a cover. Heat the crucible for about half an hour. As some of the sulphur burns, the experiment should be performed in a well-ventilated room or out of doors.

When the heated mass has cooled, expose it to the sunlight for a short time and then take it into a dark room. The mixture will give off a weird glow. If you fail to obtain the luminous effect, it will be because the compound was not heated sufficiently to combine the sulphur and calcium to form the calcium sulphide.

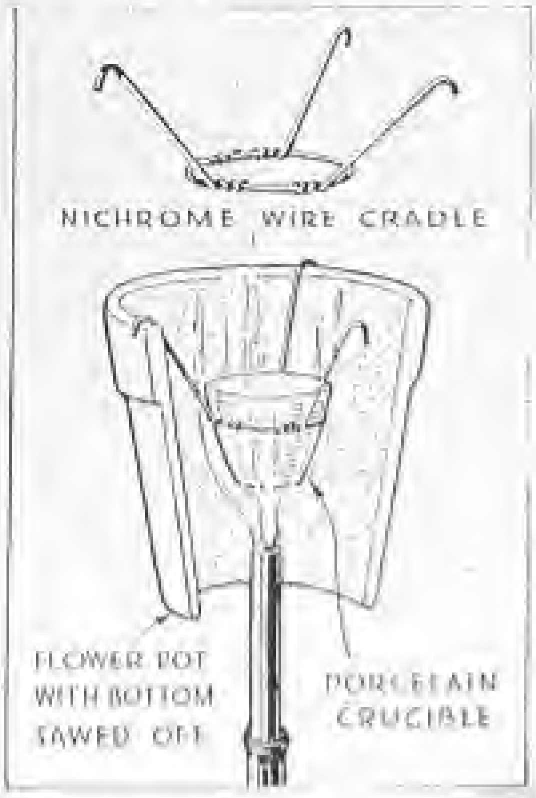
To obtain a high temperature with an ordinary burner and avoid radiation losses, you can arrange the flowerpot oven shown in the illustration. Cut the bottom from a small flowerpot with a hack saw, make a basket out of lengths of nichrome wire to support the crucible, and insert the crucible. The flowerpot can be supported on a convenient ring stand. If desired, the clay bowl of a bubble pipe can be used in place of a porcelain crucible.

Another luminous compound can be made by mixing 100 grams (less than eight tablespoons) of calcium carbonate, or precipitated chalk, two grams (about one half teaspoon) of chemically pure sodium carbonate, thirty grams (two tablespoons) of sulphur, and two tenths of a gram (pinch) each of salt and bismuth nitrate. Heating over a gas burner combines the calcium carbonate and sulphur to form calcium sulphide while the sodium carbonate and salt act as a flux and the bismuth nitrate serves as an exciter.

Plaster, used on walls, is another calcium product. It sets quickly but requires years to harden fully

In our experiments with carbon dioxide (P.S.M., Aug. '32, p. 60), we found that the gas could be made by adding muriatic acid to marble chips. After heating the acid and the marble, a thick, syrupy solution of calcium chloride resulted. This same solution diluted with water can be used to illustrate the properties of hard water.

Hard water, as you have no doubt

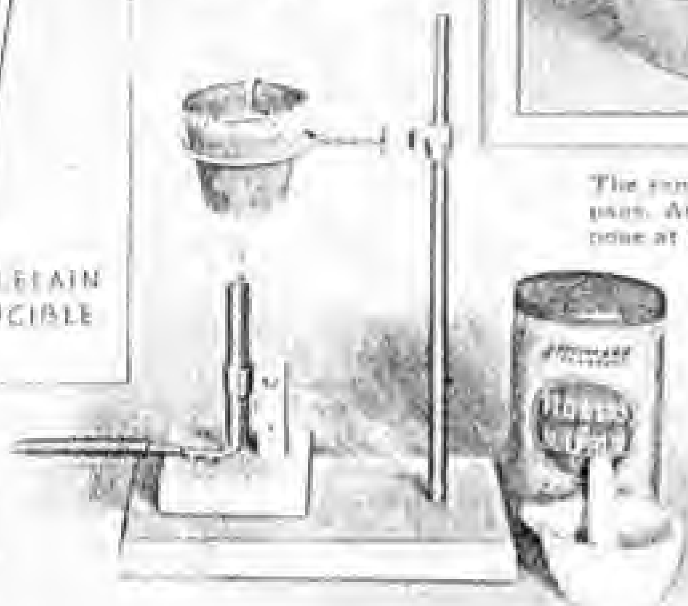


HOW TO MAKE
HEAT RETAINER

At the top of drawing is shown the cradle made of nichrome wire so shaped that it hooks over the edge of a flowerpot. It then holds crucible above a flame and secures great heat

To make luminous dust out of calcium and flowers of sulphur, as much heat as possible is needed. The apparatus, made as shown at left, is used in this experiment which is demonstrated below. The flowerpot is used to prevent a too rapid loss of heat by radiation

The same amount of soap has been used in the water in each of these pans. At the left, a large amount of lather has been developed and none at right. Calcium chloride, added to water, right, made it hard



Mortar, made of lime, sand and cement, is used in building operations

Putty, with which window panes are held in place, contains a form of calcium carbonate

found, will not lather well unless a large quantity of soap is used. This is due to the fact that the water contains certain chemicals that combine with the soap to form a precipitate.

To show this experimentally, drop a piece of calcium chloride about the size of a pea or pour some of the calcium chloride solution into a pint of soft water. After the chemical has dissolved you will find it difficult to obtain a lather until a large amount of soap is used. For comparison, lather your soap in a pint of untreated water.

Examine the treated hard water carefully. You will note that a white precipitate is formed when the soap is added. As soon as the soap reacts with all of the calcium chloride in the water, however, suds will start to appear. It is the need for a large quantity of soap that makes hard water wasteful.

It is possible to treat hard water chemically to remove the hardening compound and make it soft. In cases where calcium chloride is the offending chemical in the water, sodium carbonate (soda ash, sal soda, or washing soda) can be added to precipitate the calcium carbonate.

Other compounds of calcium may cause water to be hard. For example, take some lime water and bubble carbon dioxide into it by blowing through a straw or glass tube. At first, a white precipitate of calcium carbonate will form. Continue to blow through the tube and eventually the precipitate will disappear as quickly as it appeared. This is due to the fact that the carbon dioxide converts the calcium-carbonate precipitate, first formed, into calcium bicarbonate, a water-soluble chemical.

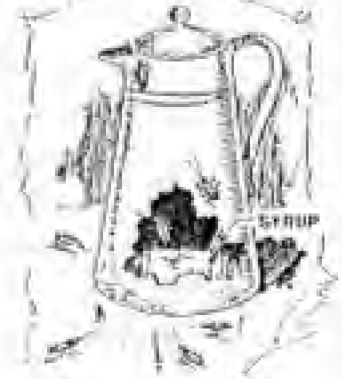
The solution that results is said to be temporarily hard. If it is heated, however, the bicarbonate breaks down to form calcium carbonate which is precipitated and the water is softened. Water that cannot be made soft by heating is called permanently hard.

Inspect the inside of your kitchen water kettle. If the sides and bottom are coated with a hard scale it shows that the water used is more or less hard. In boiling the water, the calcium carbonate precipitated forms a "fur" or brittle scale on the surface of the metal. This same action is present in steam boilers supplied with hard water. Being a poor conductor of heat, the calcium carbonate coating lowers the efficiency of the boiler. For this reason, industrial companies located where only hard water can be obtained often treat the water chemically before it is used in the boiler.

By making use of a curious property of calcium acetate, the home experimenter can prepare a novel form of solid alcohol similar to the jellied substance often referred to as "canned heat." The calcium acetate is made up as a saturated solution by adding the chemical to water until the solution will dissolve no more of the solid. One volume of this solution is added to nine parts of denatured alcohol.

Immediately, a grayish-white jellylike precipitate will be formed. Reaching an almost solid condition, it will remain in the mixing beaker even when the container is inverted. By cutting around the sides with a knife, loosen the mass and place it on the flat tin top of a can or bottle. Bring a lighted match near its upper surface and you will note that the jellied substance will burn with the colorless flame characteristic of alcohol.

A Sure-Catch Roach Trap

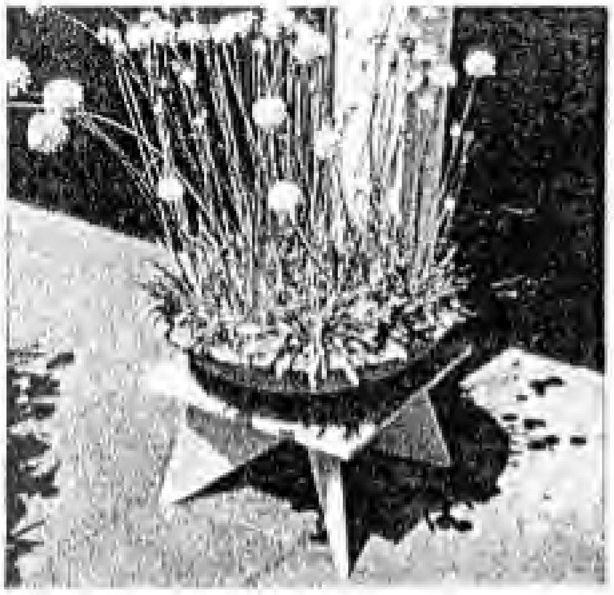


To make a good roach trap, get a small glass sirup or molasses pitcher, with the spout nearly level as shown in the drawing. It should be large enough to admit the big roaches. The cover of the pitcher has a lip which fits tightly down over the spout opening and must be turned aside when used as a trap, leaving the spout opening uncovered. Put some jelly, gravy or bits of fish in the bottom of the pitcher, and the roaches will find their way in through the open spout. They cannot get out, however, because they are unable to hold their bodies up while they attempt to get on the horizontal part of the spout from the inside.

 THE SURVIVOR Vol. 6

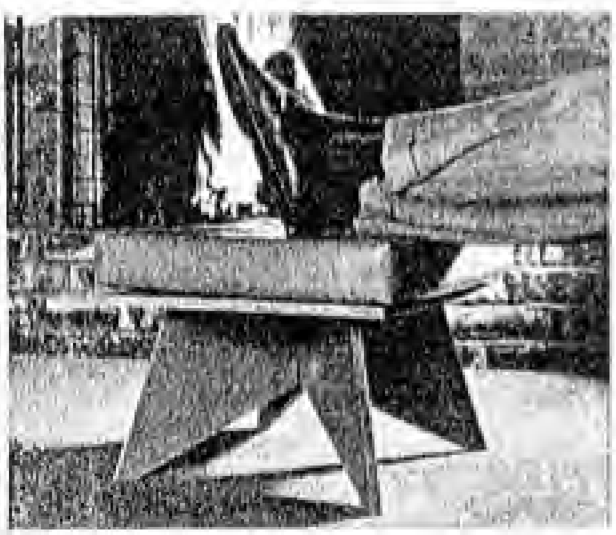
PLYWOOD MAGIC: *You make these eight stools from one 4 by 8-foot plywood panel*

SUNSET
AUGUST 1961

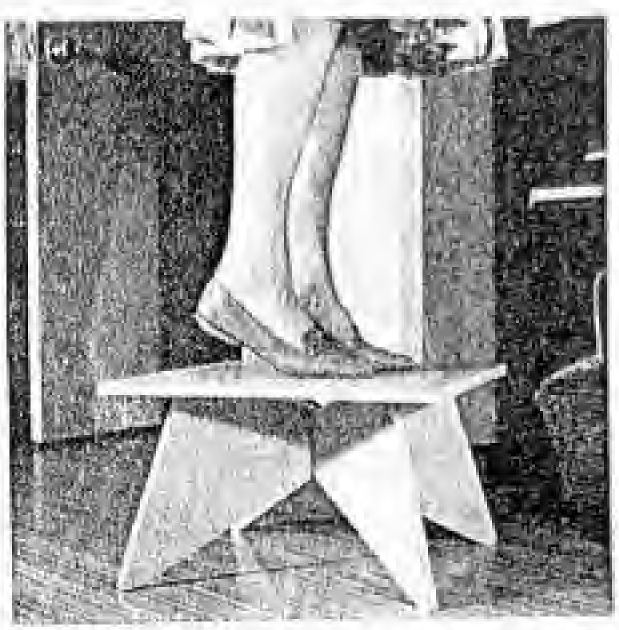


Make them *of exterior plywood if you want to use one or more for planter stands*

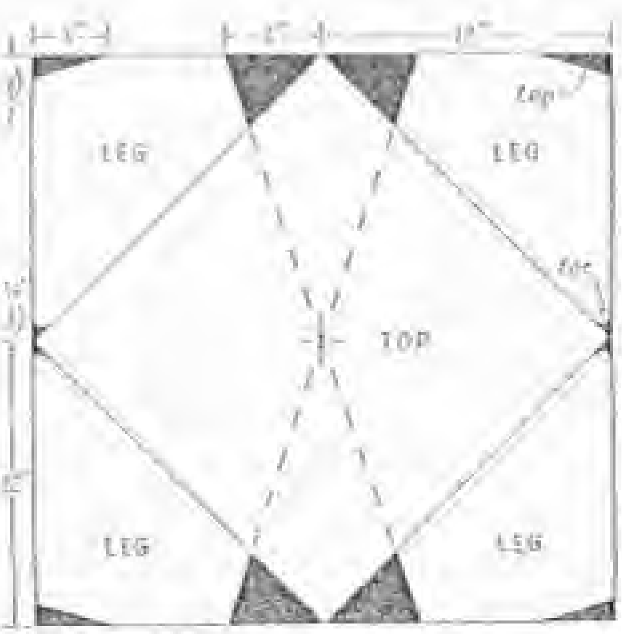
Every part *of these eight stools except the nails and glue came from one standard 4 by 8-foot panel of ½-inch plywood, the same as the panel shown here behind them*



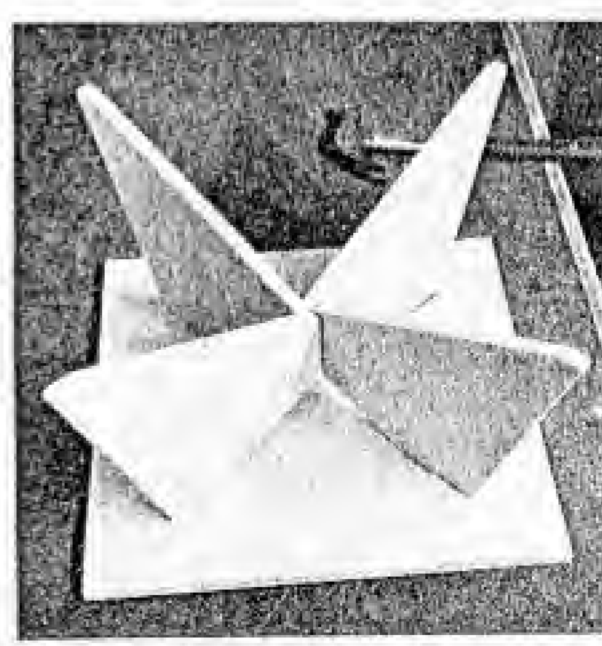
Add standard *17-inch plastic-covered cushion, and you have an ottoman or hassock*



Stable, sturdy, *these also make excellent step stools for the kitchen or utility*



Pattern *for cutting from 2-foot squares of plywood. Only shaded areas are wasted*



Underside. *You glue and nail the legs together, then glue and nail them to the top*

Simple, versatile, inexpensive: That's the quickest way to summarize the virtues of these handy plywood stools.

They make good furniture for children, have many other uses around the house, and could hardly be easier to build. Surprisingly, just a 2-foot square of ½-inch plywood yields a complete stool; a standard panel (4 by 8 feet) gives you eight, at very low cost.

Each stool is 17 inches square and stands approximately 10½ inches high. If you wish to use a cushion, you can add a ½ by 1-inch hardwood trim around the top's edges, which will give a ½-inch high rim to keep the cushion in place.

To start, draw the cutting pattern carefully on heavy paper and transfer it to each 2-foot plywood square with carbon paper or pin pricks. If making several stools, you can have the lumber yard cut your plywood to uniform 2-foot squares. Cut the legs and top from each square with a power saw or hand saw.

Note (see underside view) that each leg abuts on and is nailed to the inner end of the next leg. Assemble with glue and just two 3-penny shingle nails in each leg. Before the glue dries, turn the assembled legs right side up on a smooth surface and attach the top. As you glue and nail on the top (use 6-penny finishing nails), the legs will level themselves evenly. Finish the stools as you prefer with paint, varnish, or stain wax.

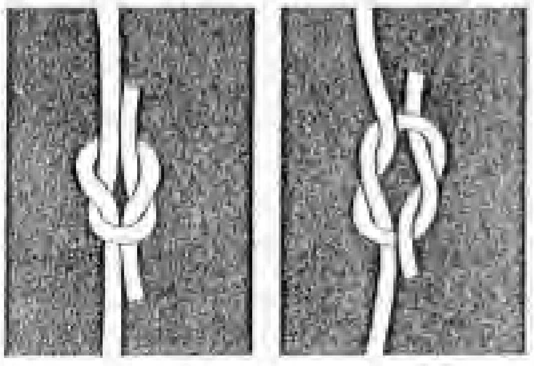
SUNSET
OCTOBER 1968

Here are ten tested knots

Take an hour or two—you'll also find it fun—to learn how to tie a few good knots and you will have a special bit of knowledge that can be helpful to you throughout the years.

Here we give a selection of tested and oft-needed knots. Ten knots are shown (there are hundreds of others) simply because no one knot is good for everything. Some do this best, some that; some work best with one kind of line or another. But knowing these ten will let you tie up practically anything.

Even gorillas tie knots, usually granny knots, with vines to make their tree nests. All knots hold because of friction, so a slippery rope or line requires a more complicated knot. Any knot is usually the weakest part of a line because it kinks and stresses the line to some degree, but a poor knot is much worse in this respect than a good one.



Square, *left; granny (no-no), right*

The square knot *is neat and easy to make. But tie the square, not the granny knot*

The square or reef knot is our most-used knot, an ancient one that is easy to tie and still one of the best for tying two ends of cord or rope together.

Good as it is, this knot has some drawbacks—it does not hold well on two ropes of different sizes or different materials, and it tends to jam somewhat when under great tension.

Note that the completed square knot consists of two uniformly intertwined loops of rope.

However, if you tie the last overhand half of the knot the opposite way (and this is easy to do), you have a less uniform knot, as shown, called the granny or lubber's knot (see the sketch above at right).

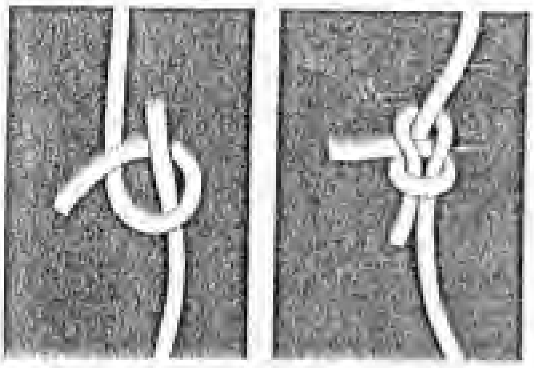
The granny is poor; under tension it will either slip apart or jam so tight it cannot be untied.

The bow tie you use on shoe laces is simply a square knot with the ends dou-

 THE SURVIVOR Vol. 6

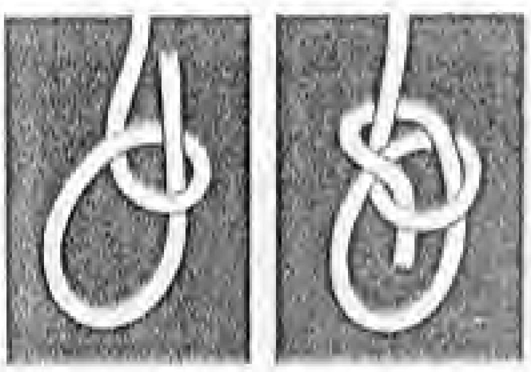
bled on the last overhand. If your shoe laces are constantly coming undone, you are probably tying them like a granny rather than a square knot.

For dissimilar ropes



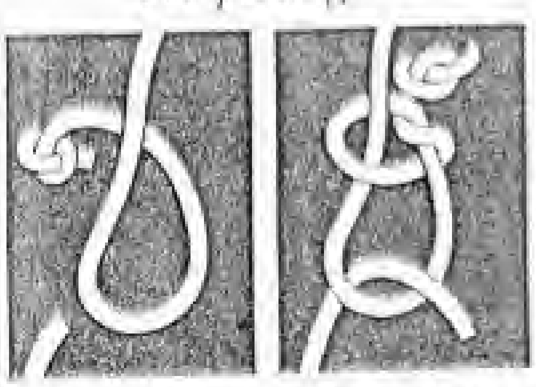
The sheet bend is a very good knot for joining two ropes of the same size or of different sizes. It holds tight, is easy to undo, and doesn't require much rope. It's simple to make with large ropes; but with string, unless you are practised, it's more difficult than the square knot. Both free ends should come out on the same side of the sheet bend, as shown; if they are on opposite sides, the knot is weakened.

For strong loops



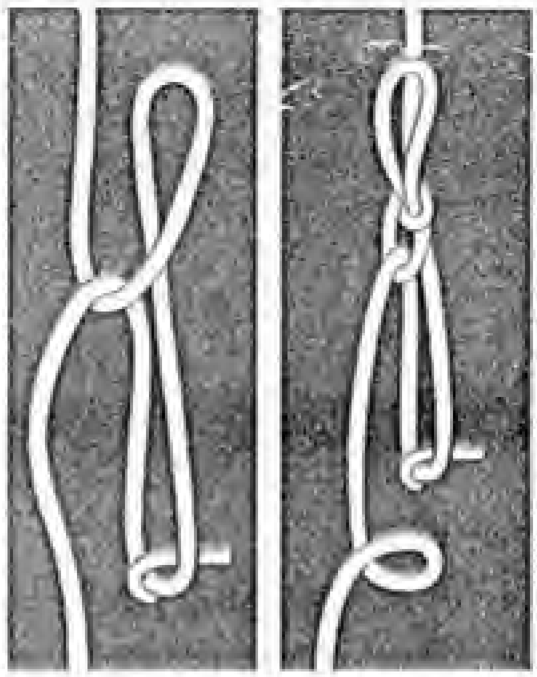
The bowline is an excellent knot for forming a secure loop in the end of a rope. It doesn't slip or jam, is easy to untie, and has a high breaking strength. Mountain climbers and sailors use it constantly. There are various bowline knots with single, double, and quadruple loops; the one shown is the most-used of all, the standard bowline.

For packages



The wrapper's knot you've probably noticed: Some store clerks flip a string around a package, quickly make a knot, and give a jerk on one end to pull everything taut without the need of a finger pressed down on a half-finished knot. This wrapper's knot is not strong, but it's quick, and ample for packages. After jerking the loose end of the string, tie it down in any way.

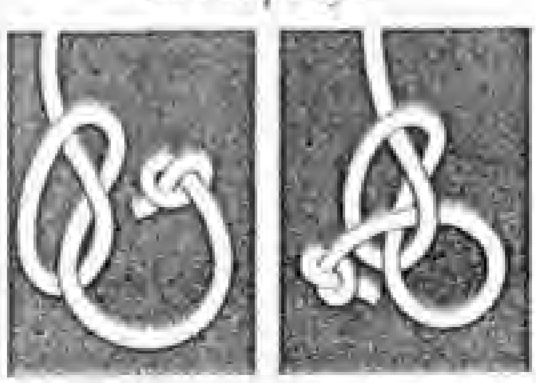
For cinching down



The trucker's knot is widely used to cinch down loads to the hooks along the sides of trucks, and you will find good use for it elsewhere—perhaps on a trailer, on a boat, or when setting up a tent.

It's unusual in that when you pull on its free end to cinch something down, you have a two-to-one mechanical advantage (as with a block and tackle) to pull everything very tight. Then you just tie the free end to the hook with a couple of half hitches or other knots. To cinch something extra tight, make a second trucker's knot on the free end of the first, secured to another hook, to give a four-to-one mechanical ratio. The knot also unties easily. Use a stout rope; most truckers use ½-inch manila.

For rope eyes

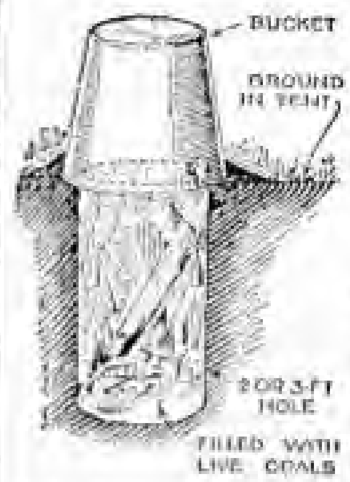


The honda is used by Westerners in converting a rope into a lariat or lasso. It gives you a small, circular loop in the end of the rope that is almost as firm as a spliced eye. You'll find many other uses for this knotted eye, especially around boats and campsites. To tie the honda, push the knotted end through a simple overhand knot exactly as illustrated; otherwise an inferior knot will result.

Popular Mechanics 1925

Heating Interior of Tent

Heating the interior of a tent on a chilly night, or when clothes are to be dried, is usually a matter of considerable difficulty when a stove is unavailable. It is out of the question to light an open fire, as the smoke would be intolerable.



A large metal can, or pail, is inverted on the ground inside the tent, and a mark made around the edge. Inside this circle a hole, 2 or 3 ft. deep, is made. This hole is filled with live coals from an outside fire, and the bucket, or can, is pressed down over the top. Earth may be piled around the edge to make it absolutely smoke-tight. In a short time the tent will be comfortably warm, and the bucket will continue to radiate heat for hours with no danger from fire and smoke.—S. Leonard Bastin, Bournemouth, Eng.

Popular Mechanics April, 1937

Pail Holder for Your Ladder Is Quickly Adjusted

By merely tipping this pail holder upward, you can adjust it quickly to any height

Made from three pieces of flat iron and a wedge-shaped wood block as indicated, this pail holder slips over the ladder rail and is quickly adjusted to any height by tilting it upward slightly, and pushing it along the rail. It is much better than a hook slipped over one of the rungs, as it holds the pail at the side of the ladder where it is easy to reach.

Popular Science
August, 1933

PROPELLERS

Sending up kite propellers to twirl on string.

WHIRL UP TO KITE

Kite propellers of balsa wood or any other very light wood will greatly increase the interest of kite flying. These propellers may be of any convenient size. A propeller 6 in. long with the blade approximately ¾ in. wide has been found generally satisfactory.

A hole is drilled in the center of the propeller for the kite string. When the kite is in the air, the end of the string can be passed through the hole, and the wind will twirl the propeller and carry it rapidly up the string to the kite, where it will continue to rotate as long as the kite is in the air. A series of propellers may be sent up to the kite until their weight becomes too great.

Another way of using them is to place knots in the kite string at, say, 100-ft. intervals. Use one propeller between each pair of knots and place a small glass bead between each propeller and the knot ahead of it. As the kite string is unwound, each propeller will twirl and follow up to the next knot, where the bead will act as a thrust bearing. The kite string will have a unique and attractive appearance with propellers whirling at spaced intervals along it, especially if the propellers are brightly colored with either enamel or lacquer.—William E. Galbreath.

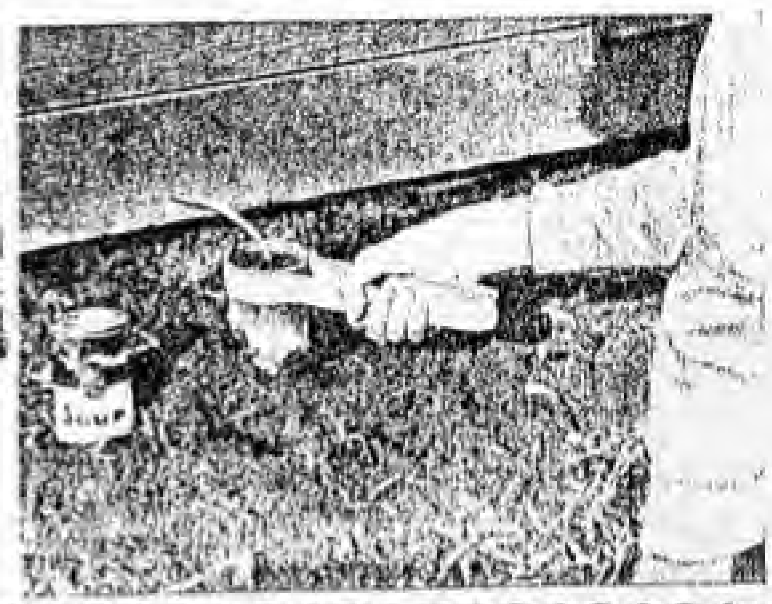
Popular Science April, 1938

Tin-Can Tool for Transplanting Seedlings

For transplanting purposes in the garden, a handy tool may be made as shown below. A handle of 1-in. band iron is bent and riveted to a small tin can, from which both ends have been removed. Jagged teeth are then cut in the lower end, and the can is also cut lengthwise into halves. These are separated a little by bending the handle.

To use, press the can into the soil, squeeze the handle, and lift out the dirt where the seedling plant is to be set out. Place the tool over the seedling, lift it out with the surrounding soil, deposit it in the hole first made, and press down the soil.—Charles M. Rice.

The can is first riveted to the handle, then cut as shown with tin snips. It is worked like a pair of tongs, as at the right

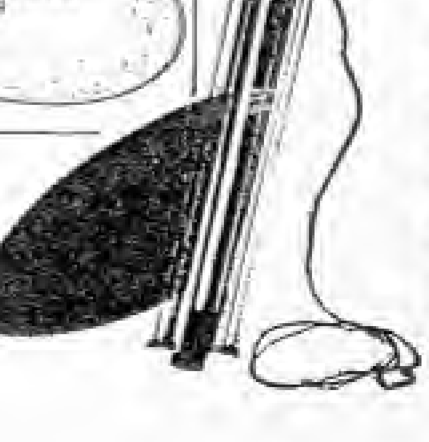


As it is swung around at the end of a string, the toy gives a combination of peculiar noises

Popular Science Monthly — Feb. 1936

NEW WHIRLING-HARP TOY GIVES WEIRD NOISES

The whirling harp consists of a round stick with two crosspieces over which rubber bands may be stretched. The stick is slotted to receive a thick pasteboard fin to steer the device



When swung around the head at the end of a cord, the whirling-harp toy illustrated above and at the left will produce a weird combination of sounds that resembles angry hornets, zooming airplanes, racing autos, and whining puppies.

This novelty consists simply of a heavy round backbone with a thick pasteboard fin and two cross arms upon which rubber bands are tightly stretched. Varying the tension of the bands gives different sound effects. It may be necessary to shorten the bands by tying knots in the rubber if they are not tight enough at first.—H. S.

Growing plants from cuttings

SUNSET JULY 1969

Growing your own plants from cuttings is something like making your own sourdough French bread: It's easier to pick up the finished product from a retailer. Nevertheless, many people gain personal satisfaction from acquiring the skills their grandparents found necessary for survival. And it's nice to be able to grow something from a "slip" contributed by a friend, especially if the plant is rare or if the name is lost and you can't possibly buy the plant from the nursery.

The best time to start softwood cuttings is early summer or midsummer for most plants.

Watch an expert selecting cutting wood: he bends tip growth with his fingers, looking for wood that will snap when bent sharply. If too young, the wood will crush; if too old, it will bend without snapping, or it will splinter.

For rooting medium you can use coarse sand; a half peat moss, half sand mixture; perlite and peat moss, or vermiculite.

Don't let the cuttings dry out at any time.

Remove leaves from any nodes that will go below the medium. If the cutting has very large leaves, reduce their area by cutting off part of the leaf. Don't remove too much: the more leaf you can retain, the faster the cutting will root, but too much leaf will transpire more water than the cutting can take up, causing wilt. Dipping the base of the cutting into a rooting hormone will increase the percentage of successful "takes." Insert cuttings and water them in thoroughly.

At this stage of the process, your enemies are wilting and root rot or other fungi. Fight wilting by keeping the air around the cuttings humid. Any device that slows down evaporation and keeps off wind and hot sun will help. We show some in the drawings here.

To control rot, see that the rooting medium isn't too wet, and keep condensed moisture from dripping onto the cuttings. Ventilate occasionally if condensation seems unusually heavy.

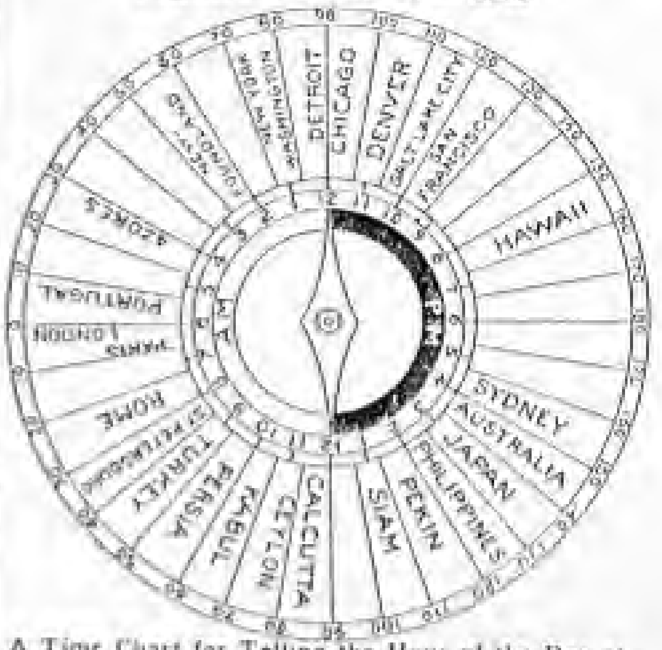
Most important: Start with healthy plant material, fresh rooting medium, and clean pots or flats.

When cuttings are rooted, pot them up carefully and continue to give them coolness, shade, and humidity until they are well established.

Simple devices *to help with cuttings include glass jars (sketches 1 and 2), plastic bags (3 and 5), glass panes or sash (4, 6, 7). Lath rack shades cuttings in the last sketch*

Compass Time Chart

Popular Mechanics — 1915



A Time Chart for Telling the Hour of the Day at Any Place on the Globe

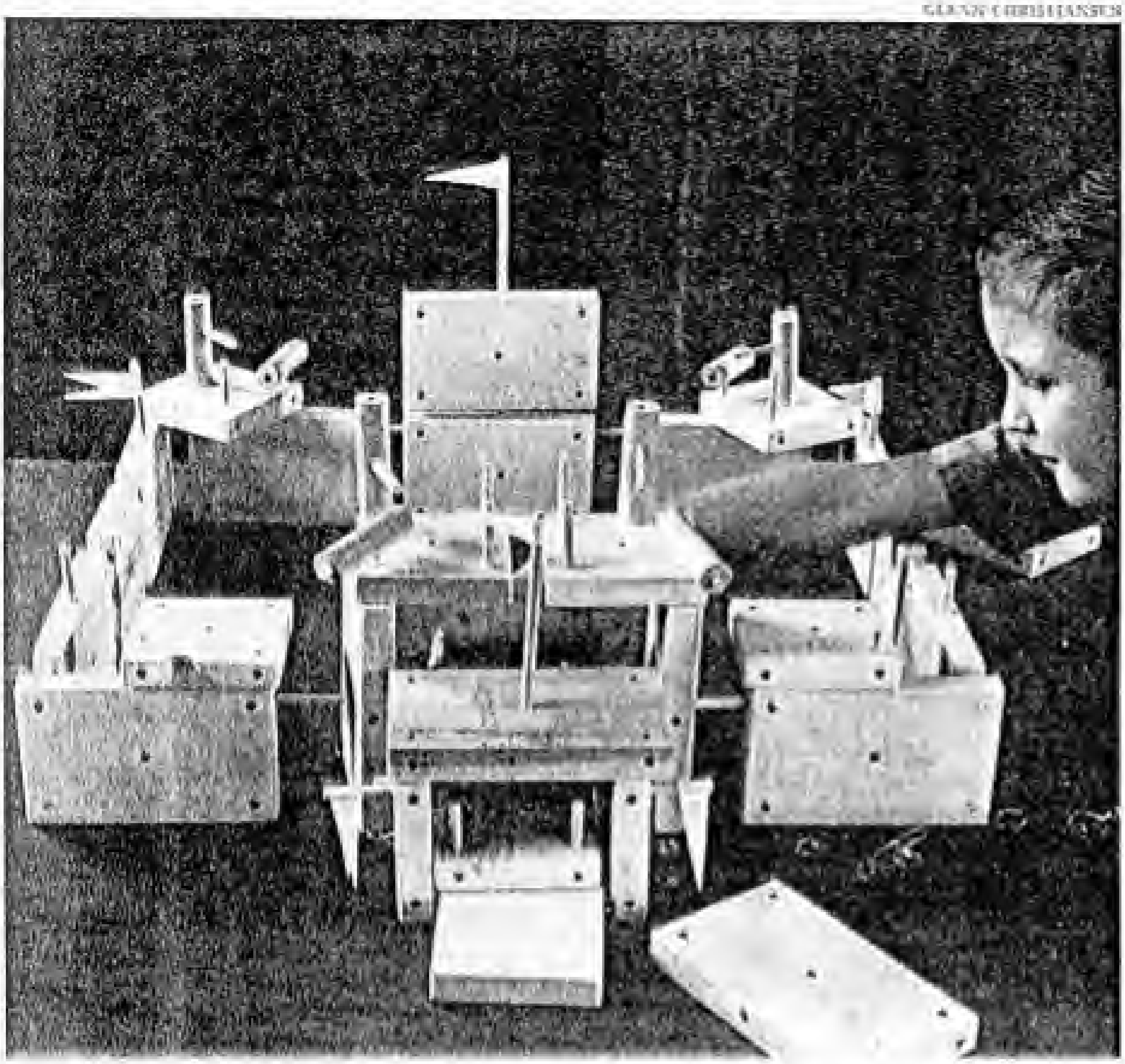
A very instructive little instrument can be easily made for telling the time of any location on the globe. Its construction is extremely simple. Draw a circle, about 1½ in. in diameter, on a piece of paper and then draw a larger circle, about 4 in. in diameter, around the first one. Divide the circles into 36 equal parts and draw lines from one circle to the other like the spokes in a wheel. These divisions will be 10 deg., or 40 minutes of time, apart. They should be numbered around the outside, commencing at a point marked 0 and marking the numbers by tens each way until they meet at 180 deg.

Using a map of the eastern and western hemispheres, write the names of the different cities on the globe in their respective degrees of longitude. The center, or inside, of the smaller circle is divided into 24 divisions representing the hours of the day and night, and these are marked from 1 to 12, the left side being forenoon, and the right, afternoon. The noon mark must be set on the line nearest to the location in which the instrument is to be used. For instance, if the instrument is to be used in Chicago, it is set as shown in the sketch.

The disk is mounted on a thin piece of board and a pin is driven through the center from the back side so as to make a projecting point on the upper side on which to place the magnetized needle of a compass. The needle may be taken from any cheap compass.

All that is necessary to do, to tell what time it is in any other city or country, is to turn the instrument so that the name of that place points toward the sun, when the north end of the compass needle will point on the disk to the time it is in that city or locality.

GLENN CHRISTIANSEN



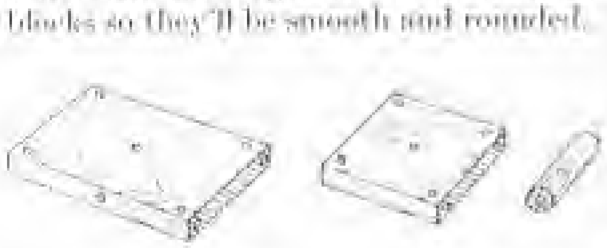
Completed fort *awaits battle. Flagpoles and pikes are ½-inch dowels of various lengths*

A head start in architecture

SUNSET Feb. 1967

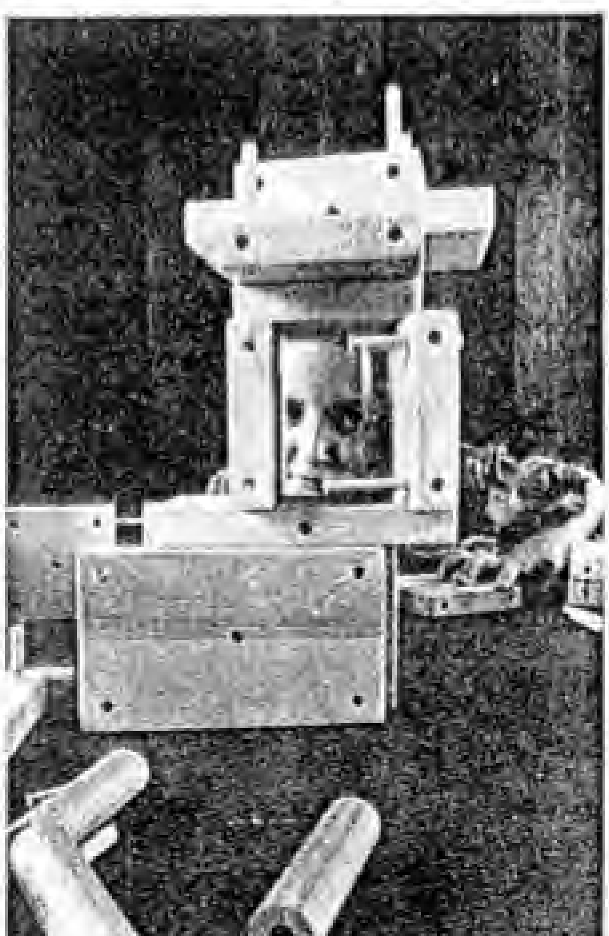
Sunset designs doll houses for little girls, but for the boys we've discovered it's more fun to provide a set of blocks and let them build what they will.

To make the set pictured, cut 4 by 4 pine boards into 3½-inch and 6-inch blocks. Drill ½-inch holes right through the thickness of each block, ½ inch in from each corner and in the middle. Drill a matching pair of ½-inch-deep holes in each end and one in the middle of each side. Sand the edges and corners of the blocks so they'll be smooth and rounded.



Make connecting pieces of ½-inch-diameter dowels cut into 2-inch lengths. The soldiers and cannons are ¾-inch dowels, 2 inches long, with a hole in each end and the side.

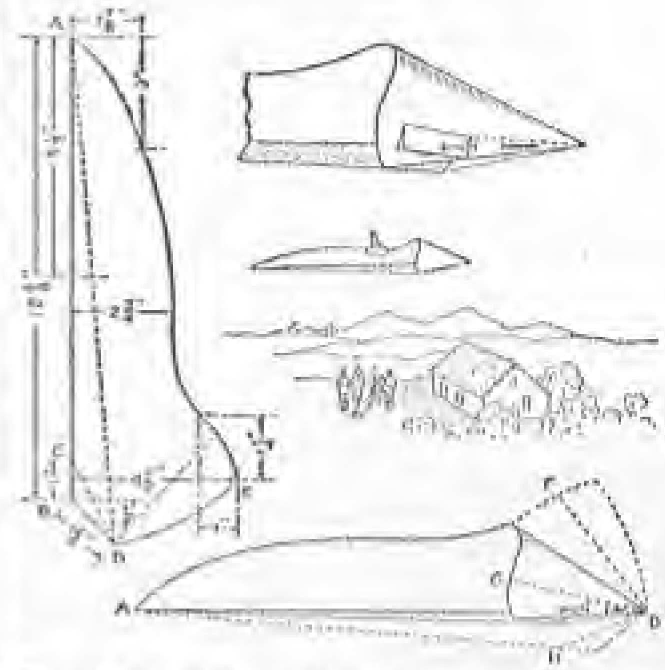
For the set pictured we made 25 blocks (15 large, 10 small). You may want to cut extras with or without holes to increase the size of the set.



Don't be surprised *if young minds find a few impromptu uses for the blocks. Cut a few extra dowels for experimentation*

Popular Mechanics — 1919

Toy Paper Glider Carefully Designed



The Glider will Travel 30 Feet, Carrying a Message, if Carefully Made

A paper glider is an interesting and useful toy that can be made quickly; it may be used out of doors, but occasions when weather conditions make it necessary to remain indoors are especially good for this form of pastime. The glider shown in the sketch was worked out after considerable testing. With a toss it travels 20 to 30 ft., on a level keel, with a message slipped behind a pin, as shown in the upper sketch. The inventive boy may devise many play uses for the glider, in tournaments, competitions, and for "military" flights, in which the "drivers" of the devices may "annihilate armies." Practical use of the toy was made in a series of air-current tests.

The glider is made as follows: Fold a piece of paper, 10 by 15 in., lengthwise, and mark the outline shown at the left upon it. The dimensions should be followed carefully. Measure first from the end A to the point B, and then draw the slanting line to D, at an angle of 45°. Mark the width to E, and measure the other distances from A and at the middle, to determine the curve of the edge. Mark the dotted lines extending from D, which are guides for the folding of the paper to form the glider, as shown in the lower sketch. Curl the points under the side so that the line FD comes to the position DG, and pin them to the corners H, as shown in the lower sketch. The glider is tossed by holding it between the thumb and forefinger at the middle of the fold underneath it.

A KALEIDOSCOPE THAT A BOY CAN MAKE

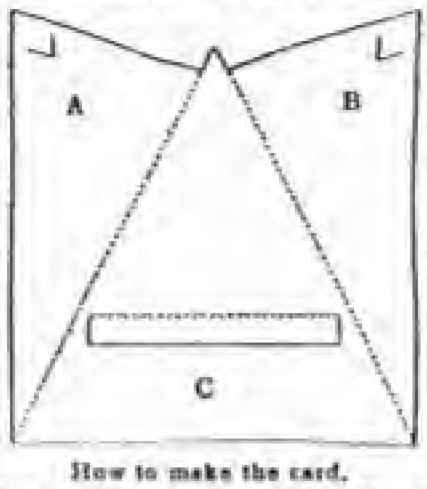
THE kaleidoscope is one of the most interesting of scientific toys, and there are few boys or girls who have not had one sometime. The name is made up of three Greek words which mean then "I see a beautiful image," and by means of the instrument an endless number of patterns, all beautiful in form, and all different from one another, can be made. As a matter of fact, so far from being a mere toy, the kaleidoscope is sometimes used by artists and pattern-makers in order to obtain new designs and patterns for carpets, wall papers, and other fabrics.

The usual form of kaleidoscope, which was invented by Sir David Brewster in 1817, is a tube in which two mirrors are arranged at an angle to one another; and between these mirrors fragments of colored glass or other colored objects are free to move about as the tube is turned round. Whatever position these colored pieces take up, they are reflected in the mirrors, and the multiplication of the pieces by reflection forms a regular design which, however irregular the colored fragments themselves may be, becomes very artistic and pleasing to the eye. The slightest shaking of the instrument produces new figures.

But the tube, with its arrangement of mirrors inside, is not essential, and there is a much simpler form of the kaleidoscope which every boy or girl can make at practically no cost, and with very little trouble.

First of all we take a piece of white cardboard, fairly tough in substance, 4 inches by 4½ inches, and at one end of its greatest length we cut it to the shape shown at the top of picture 1. Then at A and B we cut small V-shaped nicks as marked in the diagram, and an inch from the bottom, at C, we cut a line 2½ inches long, with a little line measuring one-eighth of an inch at each end, at right angles to the longer line.

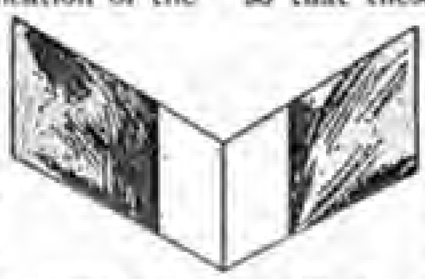
Then, on the opposite side of the card, with a penknife, we lightly score the cardboard along the directions marked by dotted lines in picture 1. This is done so that the card may be easily bent along these lines. The diagram shows exactly how we cut and score the card. The dotted lines are where we score—that is, cut only slightly into the card—and the black lines show where we cut right through. The card forms the body of the kaleidoscope.



How to make the card.

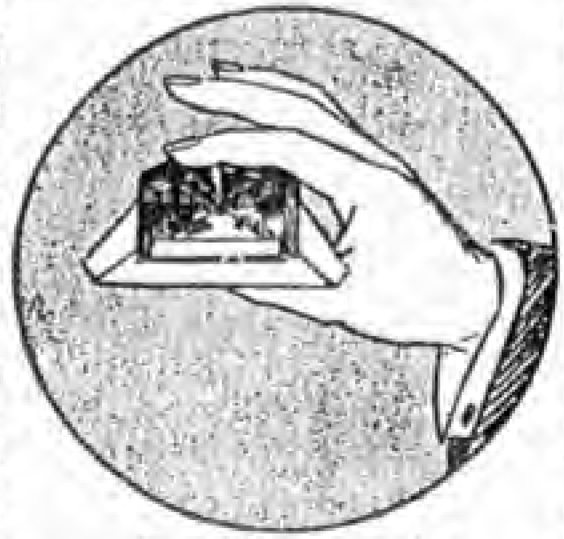
Now for the mirrors. We do not need looking-glass, but can use tin. We take two pieces of perfectly smooth and flat tin, 3 inches by 1½ inches, and, with any ordinary metal polish that may be in the house, we rub and rub these until they are burnished and shine almost like silver-plate and reflect nearly as well as looking-glass. Now, with a slip of gummed paper, we join the pieces of tin by hinging together two of their ends so that they can be opened at any angle, as in picture 2, taking care, of course, that the paper is stuck on the dull sides of the tin, and not on the sides we have burnished so brightly.

We are now ready to put our kaleidoscope together, and this is the way it is done: We first place the white card on the table in the position shown in picture 1, with the scored lines on the under side. Then we push up the little ledge, C, that we have cut in front, and turn up the two triangular flaps on either side along the scored lines, so that these will form upright sides. Now we take the folded metal mirror, and, opening it at an angle of about sixty degrees, we place it inside the card, so that the two nicks, A and B, in the cardboard sides come over the metal and hold it in position. The turned-up ledge in the front of the card will prevent the mirror from closing up, if we have measured its position correctly.


How the mirrors are hinged.

We now place some tiny pieces of colored cardboard of various shapes on the white card between the mirrors, and, holding the kaleidoscope as shown in picture 3, we let a good light fall upon the mirrors, when we see in them a beautiful design. As we shake the colored fragments about, the design changes with every movement. No matter how irregular the little pieces of colored card may be, a geometrical design will be formed, but this will be much more artistic and pleasing if the fragments of colored card are themselves cut into some regular shapes, such as circles, rings, triangles, s's, x's, and any others we care to make.

With a little practise we can cut cards to hold the mirrors at various angles, for according to the angle of the mirrors, so the number of times we see the colored objects reflected varies. Thus, when the angle is 120 we see the colored fragments three times; when the angle is 45 we see them seven times.


The kaleidoscope complete.

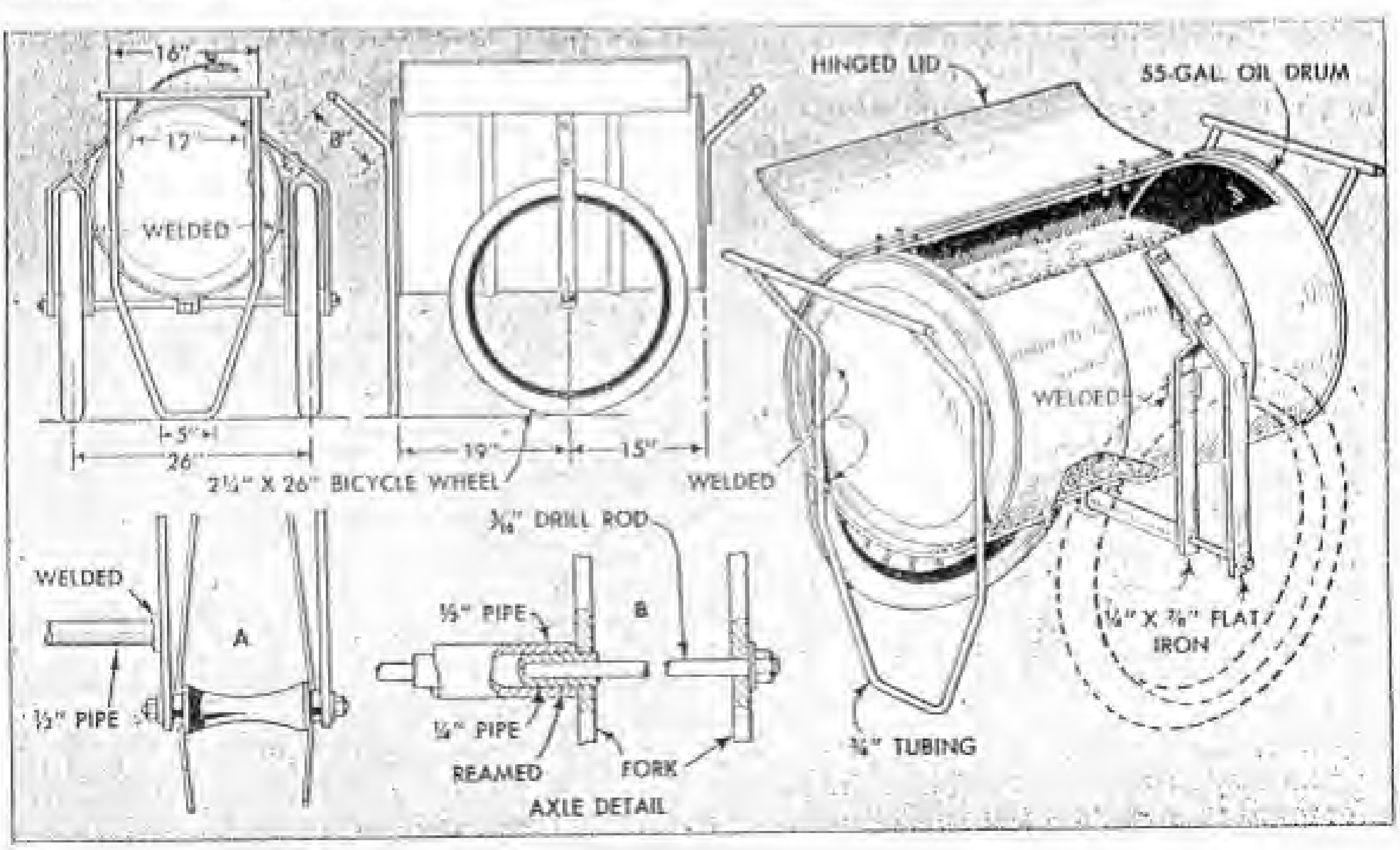
 THE SURVIVOR Vol. 6

HANDY MASH CART from oil drum

POPULAR MECHANICS
FEBRUARY 1951

By Hi Sibley

ALTHOUGH designed and built especially for a poultryman's needs by Loren Salkeld of Nuevo, Calif., this cart also is well adapted for use in the dairy barn and farrowing house where it is necessary to pass through narrow feeding alleys. It consists of an oil drum mounted on a bicycle-wheeled truck having a tread width of only 26 in. Handles welded to each end of the drum make it unnecessary to turn the cart around in narrow alleys when it has been unloaded. Cut a full-length opening in the side of the oil drum and fit a hinged sheet-metal lid with a latch. *Caution:* If you use a torch for cutting the drum, be sure to steam-clean the drum first to avoid the danger of an explosion. Then form handle frames from pipe, tubing or conduit and weld lengths of pipe across the free ends to provide handles. Weld the units to the ends of the drum. Note that one handle frame extends below the drum to form a foot on which the cart rests when stationary. The bicycle wheels are mounted in improvised forks, the inner member of each one being welded to the side of the drum as detailed. The outer members of the forks are held in place with bolts so that they may be removed. Details A and B show two methods of mounting wheel axles. Although most wheels can be mounted as in A, some will require the other method.

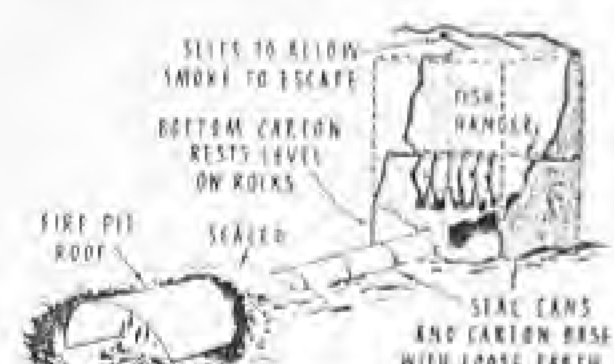


How to smoke your fish right on the spot

If you've ever wanted to try your hand at smoking fish but have been stymied by the difficulties of building a smokehouse, you may be interested in this simple one improvised by Loomis Miller, of Seattle. The materials are two cardboard cartons and a half dozen No. 10 cans (1 qt. 14 oz.) —the kind you get when you buy fruit juice in the jumbo size. Fruit cans of No. 2½ size (1 lb. 14 oz.) may be substituted. Three two-foot lengths of 6-inch diameter stove pipe are also ideal (80 cents a length, approximately).

Mr. Miller constructed his smoker, while camping near Kalaloch on Washington's ocean strip, to care for a lucky catch of ocean smelt. During a week, he smoked three batches, a total of about 300 fish. Any fish can be smoked by this method, but the oily fish, such as smelt, whitefish, lake trout, or salmon make the most delicious product.

Constructing the smoker. Mr. Miller used six No. 10 juice cans for the smoke pipe, by removing the ends from each can and laying them end to end up a slight slope from a 6-inch-deep fire pit. A scrap of sheet iron picked up at the beach roofed the small fire pit, but a seventh can cut open and flattened could just as well have been used. Five feet of smoke pipe proved long enough to cool the smoke before it entered the cardboard carton smoke chamber. To avoid the remote possibility



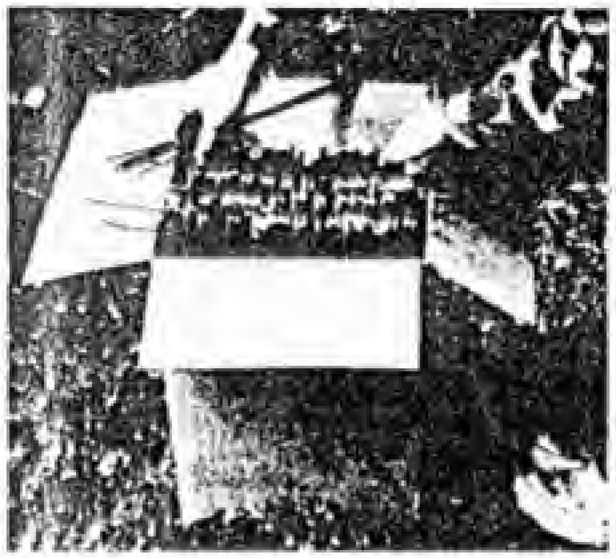
Smoke house materials, *plus some camping gear, can all be packed in large carton*

of smoke, heat, or spark damage, you might line the carton with foil.

Mr. Miller cut a 3 by 6-inch hole in the bottom of the largest box, set it over the high end of the smoke pipe, leveled the box up, and then weighted it with rocks. Earth and gravel, banked over the pipe and around the bottom of the box, sealed in the smoke. (Keep out combustible matter like wood chips or moss.)

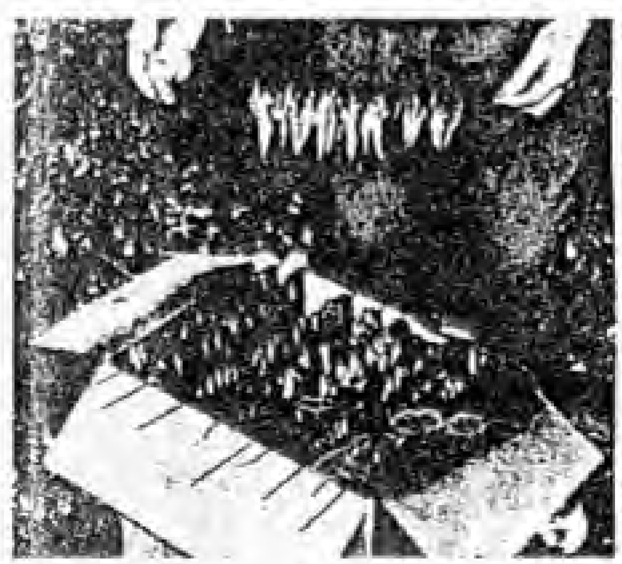
Coat hangers provided the wires to suspend the fish. Each hanger, straightened and cut, made two rods. Slits cut in the bottom of the second box, which was then up-ended to cover the one holding the fish, allowed some smoke to escape.

Preparing the fish. Soak the clean fish overnight in a strong brine of about 12 ounces of salt to a gallon of water—a 30° to 32° salinometer reading. (Most laboratory equipment and supply houses sell salinometers for about $2.50.) Color and flavor improve with the addition of ½ ounce saltpeter and ¼ ounce ascorbic acid to each gallon of brine. String each fish through the thickest part. (Don't string through the tails; fish may drop off during smoking.) Space fish to let smoke circulate.



Space the threaded *fish along top of carton, allowing room for smoke to circulate*

Smoke is trapped *by fire pit roof and travels up slightly sloped cooling "pipe"*



After three hours *of smoking, start testing your catch for flavor and doneness*

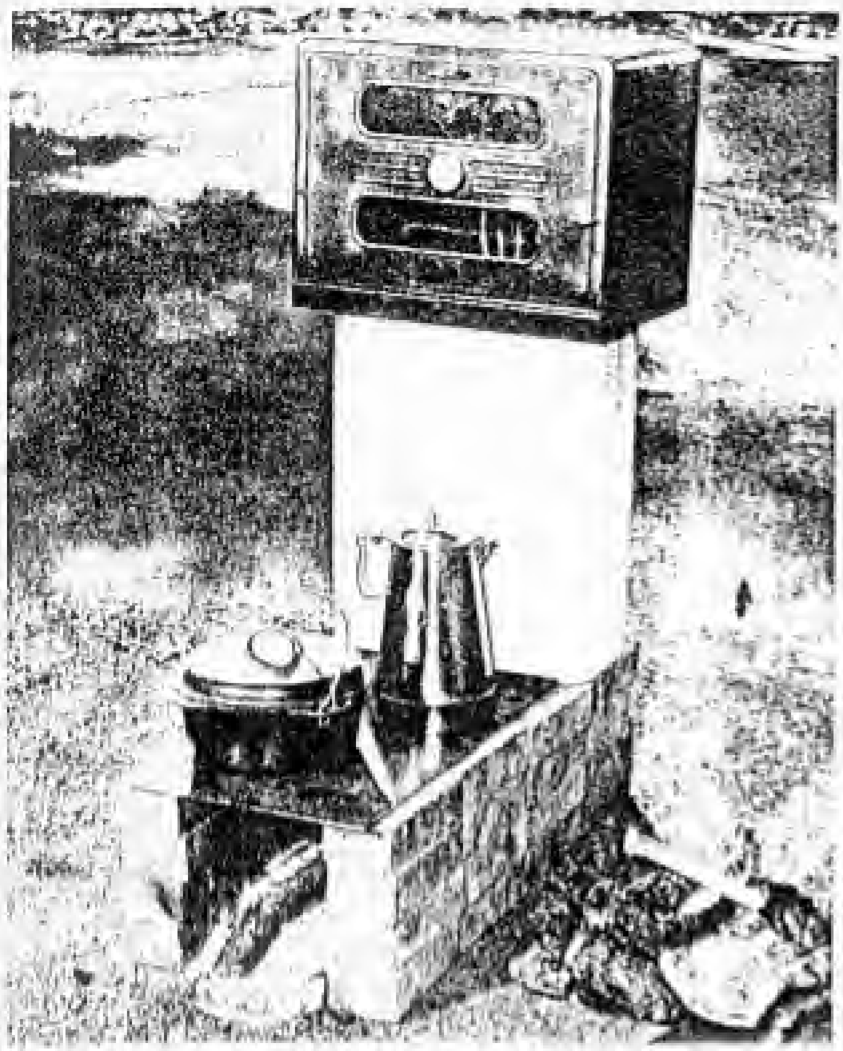
Make sure fish surfaces are dry before smoking. Smoke deposits creosote (found in all woods) on wet surfaces.

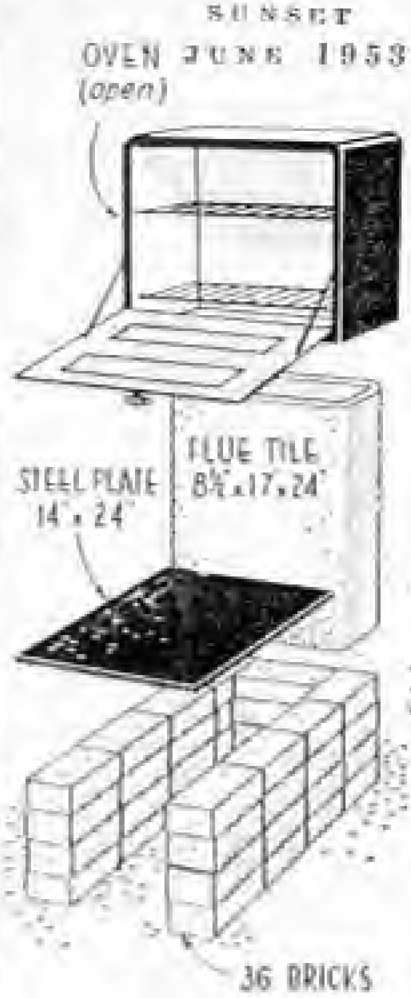
Smoking. When all fish are in the smoker, start your fire. Because it is difficult to start a blazing fire in the small fire pit, which is most efficient for this smoking process, it is easiest to start with coals from your campfire. Top this base fire with hardwood for smoking: oak, alder, wild cherry, wild crabapple, madrona, or similar woods. Avoid using resinous woods like pine, fir, cedar or spruce; they give the fish a pine tar flavor and too dark a color. Start with a small, very smoky fire to flavor and harden the fish. Then increase the heat slightly after the first few hours to dry the meat before smoking is completed. After your fire is burning, a filling of green hard wood will usually smoulder for two or three hours. Small fish such as smelt, whitefish, or small trout will require from four to six hours of smoking. Salmon or large trout should be split for smoking and require more time, according to the thickness of the flesh. Dry-smoked fish will keep for several weeks without refrigeration. To kipper your fish, increase heat to cook the flesh faster. Kippered fish must be promptly eaten or refrigerated.

Leaves Troweled in Sidewalk Produce Neat Border

A variety of designs can be worked out by using different shaped leaves of various trees

After applying the finishing coat to a freshly laid sidewalk, tree leaves were troweled into the wet surface along the edges. When the concrete had set and the leaves dried, they were washed away with a garden hose, leaving their impressions in the surface. The border shown was made with elm leaves.





This economical smoke oven was built from readily available materials in less than 15 minutes. Meat and fish roasted in the oven retain their natural juices and moisture, and emerge with a tantalizing smoke flavor. Note the handy stove top

Here's a demountable smoke oven

The smoke roasted meats and fish that come out of this close cousin to a Chinese oven are real discoveries in good eating. Your smoke oven will cost less than $15, even if you have to buy each one of the necessary materials. In your own back yard you may be able to find enough old bricks for the job and, perhaps, a sheet of steel for the top. Here's the recipe for building the complete—and portable—assembly:

3 dozen bricks

1 clay flue tile, 8½ by 17 by 24 inches

1 portable oven. (Hardware stores and mail order houses usually stock them or can order one for you. All you have to do is remove the small metal shield on the bottom. Cost about $5.)

1 piece of metal 14 by 26 inches. (Anything thick enough to withstand the fire below without bending is all right. We used 3/16-inch steel.)

Assemble the materials on level ground as shown in the photograph above. This shouldn't take longer than 15 minutes. One of the best things about the oven is that it can be taken down and stored when not in use.

Since there is no bottom to the oven, the lowest rack merely rests on top of the flue tile. Make sure that the oven you buy is large enough to completely surround the top of the flue tile you use. In that way the smoke is forced up into the oven, circulates, then escapes out around the sides of the flue tile.

Lay a small fire of kindling wood and charcoal in the front end of the brick tunnel. When the charcoal is thoroughly ignited, add small pieces of green wood—dry wood will give you flame and heat but no smoke. Use oak, apple, alder, or any fruit wood. Don't use pine, fir, or any of the resinous woods; they will impart a harsh unpleasant flavor to the meat.

Place the metal top on the brick tunnel, and put several bricks in front of the opening to control the draft. Now you're ready to start cooking.

We tried two methods of smoking: placing the meat directly on the oven racks, and hanging it down into the chimney. Cooking time is somewhat shorter for meat hung in the chimney, and flavors are similar. Use heavy gauge wire, piercing the meat deeply enough so that the wire won't pull loose. Lower the meat into the chimney, then secure the wire firmly over the bottom rack of the oven. Don't forget that you'll have to remove the hot wire and meat as soon as it is cooked.

The oven can be pre-heated, then loaded with food; or loaded beforehand, then placed on the flue tile. Times listed below are for foods cooked on racks in the oven. Since it is hotter in the chimney, meats hung from the rack will take 15 minutes to half an hour less cooking time.

HOW AND WHAT TO COOK IN YOUR SMOKER-ROASTER

You should keep your fire low enough so that the temperature in the oven stays between 300 and 350°. If the meat seems to be cooking too fast at first, set oven off until you have more smoke and less fire.

There's no limit to the variety of meats and fish that you can smoke-roast. Not only will the food have a wonderful smoky flavor, but also, as a consequence of the slow cooking process, meat and fish retain their natural juices and flavors.

Fish

We tried both salmon steaks and fresh trout. Either needs only a good rubbing with salt and pepper and an occasional basting with equal parts of melted butter and hot water. Use a good white wine with the butter if you prefer, but the smoke flavor is more pronounced with only the butter-water sauce. Time: 30 minutes for small trout, 45 minutes for inch-thick salmon steaks. Do not try to turn the fish, as it will crumble.

Save several of the smoked trout (if you can) and chill them in the refrigerator. Boned and cut in small pieces, they make mouth-watering hors d'oeuvres.

Chicken

Rub well with salt, pepper, brown sugar, and tarragon vinegar. Turn and baste the chicken occasionally with a mixture of butter and warm water for moist, even cooking. Smoking will impart a golden-orange color to the chicken unlike any you've seen before. Time: 2½ to 3 hours.

Steak

Smoked steak, of course, will be different from what you're accustomed to. Cooked through, it will still be moist; and it will have the handsome tinge of brick color peculiar to smoked meat.

Prepare a large (at least an inch thick) sirloin. Rub both sides of the steak with soy sauce, then sprinkle with salt and pepper. Turn the steak and baste it occasionally with a warm mixture of half butter and half water. After steak is roasted, slice it into separate portions for serving. Time: about 2½ hours for medium. But check it sooner if this long cooking period makes you suspicious.

Spare ribs

The cooking procedure and time for spare ribs are the same as for steak.

SUNSET
JUNE 1973

Easy-to-make smoke oven. You start with a new garbage can

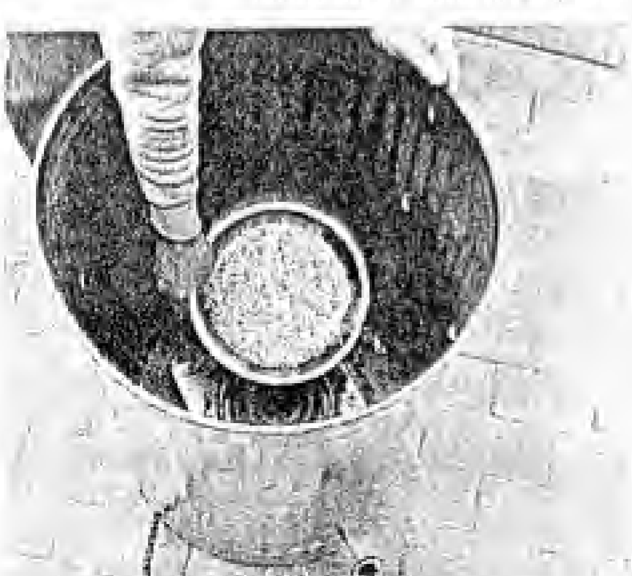
Can, *hot plate, and other materials from a hardware store should cost under $35*

Bronzed, *smoke-cooked salmon is a feast from the garbage can*
NORMAN A. PLATE

Two precooked chickens *absorb smoke flavor from smoldering chips in can. Thermometer on rack somewhere in smoke should be checked regularly*
[illegible]

NORMAN A. PLATE
Leave lid *on the can when punching holes. Two sets of holes give you two rack levels*

Finely chopped *hickory chips will make smoke. Place in pan on element until they ignite*



We've reported some unusual methods for getting smoke flavor into foods, but never before a smoke oven that's a converted garbage can.

It's simply a standard size metal garbage can fitted with an electric hot plate. The hot plate ignites a pan of wood chips. They smolder, giving off smoke that's contained in the covered can.

A garbage can smoker like this can handle a 12-pound salmon. In fact, it can do just about anything that a smokehouse can do: You can use it to add smoky flavor to nuts and cheese; dry jerky; smoke and cook fish at the same time; smoke cured meats; and smoke precooked meat and poultry just before serving.

The hot plate's heat settings give temperature control (most smokers have none).

With the smoker at a low temperature—around 90°—a chunk of cheese absorbs a pleasing amount of smoke flavor without melting. At higher temperatures where it functions at optimum efficiency, between 170° and 190°, nuts toast while getting smoky and salmon fillets or trout

Meat and poultry need precooking, but not fish. This beautiful salmon slab was in the smoke oven start to finish

cook moist and succulent, while the smoke flavor permeates them. In the middle temperature range, about 140°, you can dry jerky or smoke cured meats, cooked meats, or cooked poultry.

The pan of wood chips will smolder for 2 to 3 hours, and, once going, the smoker needs infrequent checking. By replenishing the chips, you can extend its operating time to smoke typical cured meats like ham. But these meats must first go through a curing process to be safe to eat. This treatment with a curing salt (a mixture of salt, sugar, and preservative substances called nitrates) is time-consuming; up to 10 days are needed to cure a whole ham.

If something easier and faster than the classic method of adding smoke flavor to foods is more your style, we propose an alternate technique for smoking meats and poultry. You begin by roasting them in your oven or cooking on top of the range, then let them rest in the garbage can's warm fragrant smoke.

Meats smoked this way taste like those cooked slowly in a covered barbecue—only smokier. And since you don't use curing salt, they don't have the taste and color of cured ham or corned beef. You have more control over the level of smoke flavor since you eliminate barbecuing guesswork about time and temperature. Directions for preparing meats and poultry this way are on page 144.

Without becoming involved with curing salts or precooking, you can smoke fish to perfection, dry jerky, or add delicious flavor to a favorite cheese or nuts.

Operating a garbage can smoker

You need a reliable oven thermometer to guide you in regulating the temperature in the smoker.

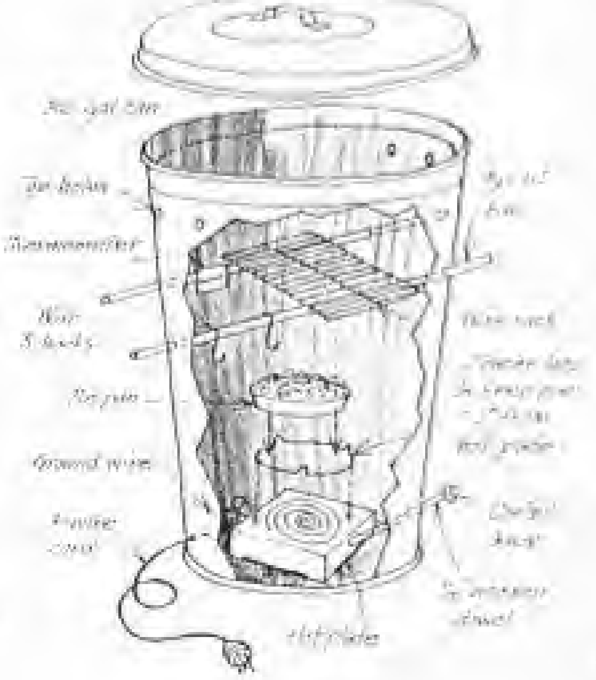
For the wood chips, use any hardwood; however, pure hickory or blends of hickory and other woods are the most readily available. You will find them at feed and fuel stores and some hardware stores. Buy the smallest chips available. If chips are larger than the size of kidney beans, you can whirl them, a little at a time, in an electric blender.

Put 2 to 3 cups finely chopped wood chips in a metal pie pan and place directly on the hot plate element. Turn the hot plate to its highest setting. As soon as the chips produce enough smoke to fill the can (about 3 to 5 minutes), lift out the pan, protecting your hands. Place a spacer loop around the element and set pan on top. (The loop holds pan about 1 inch above heat, and prevents the chips from flaming.)

Insert the bars (choose position compatible with food size; use both levels for larger quantities) and place wire racks

Trout *smoke-cooks while hanging from S-hooks supported by bars in can*

You punch holes for rack bars, electric cord. Grounding is important



Most hardware stores carry everything you'll need to put together the oven. We used a 32-gallon galvanized garbage can ($4 to $6), a single-element hot plate with a heat control knob ($12 to $18), a mercury oven thermometer ($4), wire racks (the kind used for cooling cakes), two 3/8-inch steel bars to support the rack, a pie pan, some heavy wire (to make a spacer loop between the element and pie pan), and S-hooks for hanging food, 15 feet of HPD 14-gauge three-wire cord (you may need to go to an electrical supply shop for this), a three-prong plug, and a 3/16-inch dowel as a stem extension for the hot plate's control knob.

Punch the holes for the rack bars (about 4 to 6 and 10 inches from top), control knob stem, and electric cord with a cold chisel or large spike. Use electrical tape to mask the jagged edges of the hole that the cord passes through. Since each hot plate is different, you'll have to use ingenuity to extend the heat control knob to the outside of the can. We glued a short 3/4-inch dowel inside the knob and pushed the other end into the knob stem.

Important: Since you are using a hot plate designed for indoor use, you need to add an insulated cord with a third ground wire to protect against shock. Open the hot plate and replace the two-wire cord with the asbestos-wrapped HPD cord. Secure the third green ground wire to the metal body of the hot plate. Also secure with a sheet metal screw a piece of wire from the metal hot plate body to the can itself. Plug the cord into a three-hole grounded outlet. Use the smoker oven only on dry surfaces and be careful to keep the cord dry, too.

If a fire starts in the can, unplug the hot plate. If a fire extinguisher is needed, use only the dry chemical type suitable for electrical fires.

across them; place thermometer and food on racks and put lid on can. Reduce heat as directed in the recipes that follow. Wait about 10 minutes, then check the thermometer and make further adjustments as necessary to keep the temperature steady.

Fish fillets and steaks. Fish with a moderate fat content, such as salmon, sablefish (also called butterfish or black cod), and sturgeon, smoke-cook moist and delicious. Cut fish lengthwise into boneless fillets or cut across into steaks; pieces should be ½ to 1½ inches thick.

Prepare this salt brine (enough for about 12 pounds fish): Dissolve in 2 quarts of water, 1 cup salt and 1½ cups sugar; add 3 tablespoons coarse ground pepper and 2 or 3 bay leaves. Allow fish to stand covered in brine for 3 to 6 hours in the refrigerator. Drain fish, rinse in cold water, then allow to stand uncovered until dry, about 30 minutes.

Place fillets, skin sides down, on a double thickness of cheesecloth and cut outline to follow fish. Oil wire racks and place prepared fillets (with cheesecloth) or steaks directly on racks. For additional flavor, lay a branch of fresh herbs such as bay, dill, rosemary, or tarragon on the surface of the fish. Follow operating directions at left; when chips are ignited and spacer loop is in place, adjust element heat to about medium high for temperature in can of 170°. Smoke fish for 1½ to 3½ hours (it depends on thickness) or until fish flakes when prodded with a fork in thickest part. Serve hot or cold.

Trout. Gut and rinse in cold water up to 12 whole trout (each not more than 12 inches long and about 1-pound size). Prepare salt brine as directed for fish fillets. Soak fish in brine and dry as directed. Insert S-hooks through gill and out of mouth of each fish. Smoke as for salmon but hang S-hooks over bars and smoke only for 1 hour or until fish flakes when prodded with a fork in thickest part. Serve hot or cold.

Cheese. A fairly firm cheese that will hold its shape works best. We had good results with Cheddar, Edam, Emmenthaler, fontina, fontinella, Gouda, Gruyère, jack (and dry aged jack), Muenster, Samsoe, Swiss, and tybo. Wrap a chunk of cheese (no more than about 1 pound) in a single layer of cheesecloth to help hold the shape. Follow directions at left for operating the smoker; after chips are ignited, leave pan of chips directly on element (do not use spacer loop). Reduce heat of element to low to medium low for temperature of 90° to 100° inside

Twelve-pound *filleted salmon will cook and smoke in 3 hours*

can; smoke cheese for 30 minutes to 1 hour. (The smoke turns crust golden; the darker the color, the smokier the flavor.) Cool cheese at room temperature, then wrap and refrigerate.

Nuts. Use shelled, whole almonds, filberts, macadamias, peanuts, or pecans. Spread 2 to 3 cups in a single layer in a shallow pan. Operate smoker as directed at left; when chips are ignited and spacer loop is in place, adjust element heat to medium to medium high for 170° to 190° temperature in can; smoke for 1 to 1½ hours; stir occasionally and taste a nut to check on level of smoke flavor. Serve warm or cool.

Beef jerky. You can dry about 1 to 2 pounds of meat at a time. Cut all fat from beef flank steak, brisket, or round steak. Cut meat across grain in ⅛-inch-thick strips. Marinate meat strips in a mixture of ⅓ cup soy sauce, 2 tablespoons Worcestershire, and ¾ teaspoon pepper for at least 1 hour or as long as overnight if covered and refrigerated. Lay strips in a single layer on racks.

Follow operating directions at left. When chips are ignited and spacer loop is in place, adjust element heat to about medium for 140° temperature in can. Smoke for 4 to 5 hours or until meat is well dried (it snaps when broken). For mild smoke flavor allow the chips to burn out (about 3 hours), then simply continue heat until meat dries. For more smoke flavor, replenish chips by adding about 1 cup at a time as needed. Each pound of fresh meat makes about ⅓ pound jerky. Refrigerate to store.

Cured meats. To cure meats, get instructions from companies who make curing salt (write to address on package). After curing, place cuts directly on wire racks. Operate smoker as directed at left; when chips are ignited and spacer loop is in place, adjust element heat to about medium for temperature in can of 140°. Allow about 4 hours for a 4 to 5-pound beef tongue, 6 to 8-pound pork side (bacon), or a 10-pound whole ham. After meat is cured it still must be cooked by conventional methods. □

Popular Mechanic — 1915
Combination Tool for Amateur Draftsmen

A common 6-in. mill file can be converted into a very useful tool for an amateur draftsman. Grind the end of the file as shown in the sketch and use it for prying out thumbtacks that are driven in too tightly. Grind the base of the tang into a knife blade for sharpening pencils, shaving chalk, opening envelopes, etc. Shape, by careful grinding, the part A for cutting and trimming sheets. Grind one edge of the file round and polish it for smoothing and burnishing purposes. Grind a sharp point on the tang for per-

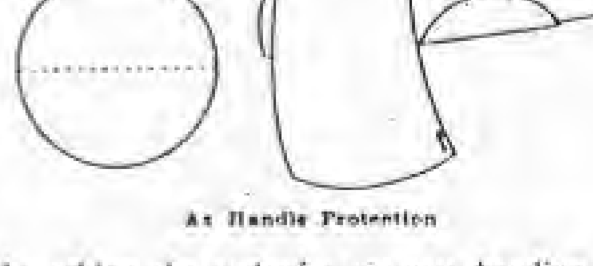
A Tool Made of a File Combining Several Tools Which are Used by a Draftsman

forating sheets. A piece of rubber stuck on the tang end answers the double purpose of a protector and eraser. The file part is used for finishing points on pencils.

Popular Mechanics January, 1903

TO SAVE AN AX HANDLE

A simple device to save an ax handle from wearing out at the weakest point is herewith shown. It is very easily made



Ax Handle Protection

by taking the end of a tin can, bending it at the dotted line and tacking it on the handle at A. It will well repay any one for the time and trouble.

 THE SURVIVOR Vol. 6

How to smoke your own

SUNSET: AUGUST 1965

If you like smoke-flavored cheese, meat, fowl, fish

Curing and smoking your own meats is an art rather than an exact science. It requires patience and attention and some sort of smoker or smoke box designed expressly for smoking (not smoke-*cooking*) foods. Two smoke boxes that you can make at home are shown, with construction details and directions for operating, in the article starting on page 86. Small portable smokers are also available in sporting goods stores for as little as $30.

You might begin with an easy project such as adding smoke flavor to cheese, link sausages, a roasting chicken, or small turkey. This will give you an opportunity to get acquainted with your smoker and learn how to control heat and amount of smoke. Sooner or later, you'll probably want to cure and smoke a whole ham, pork loin, or a side of bacon (see the how-to-do-it pictures below and on page 126).

A good thermometer is important. An oven thermometer or roast meat thermometer is satisfactory, but it should record temperatures as low as 110°. Smoking at low temperature (about 110°) preserves the natural juiciness and flavor of meats. An exception is fish, which is best smoked at temperatures around 170°.

To cure as well as smoke meats, you'll need curing salt, basically a mixture of salt and sugar. We recommend that you use a prepared curing salt that contains, in addition, special preservatives to give the meat an appetizing red color after it is smoked. You can buy curing salt from salt manufacturing companies, from butchers' equipment and supply companies, and often from feed stores, especially in rural areas. If you are unable to find curing salt in your area and would like a source from which you could order by mail, send a stamped, addressed envelope to Home Economics Department, *Sunset Magazine*, Menlo Park, Calif.

When curing salt is called for in the following directions, we have specified minimum amounts, producing mildly flavored

PORK LOIN: *First you bone it, then salt and tie*

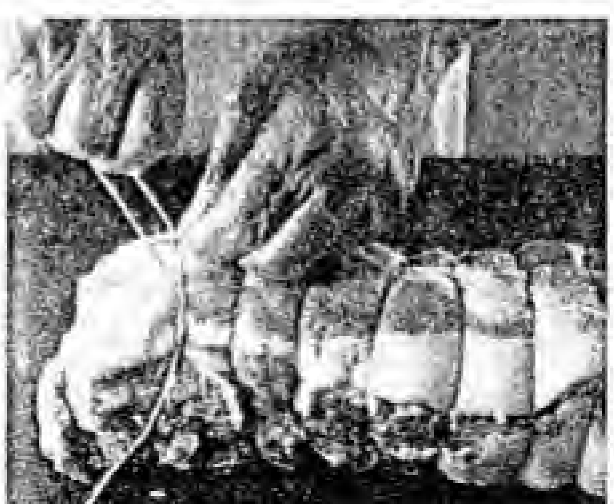
DARROW M. WATT

1. *Place loin with fat side up; slice off the blade piece and butt end. Turn meat over and cut out tenderloin strip*

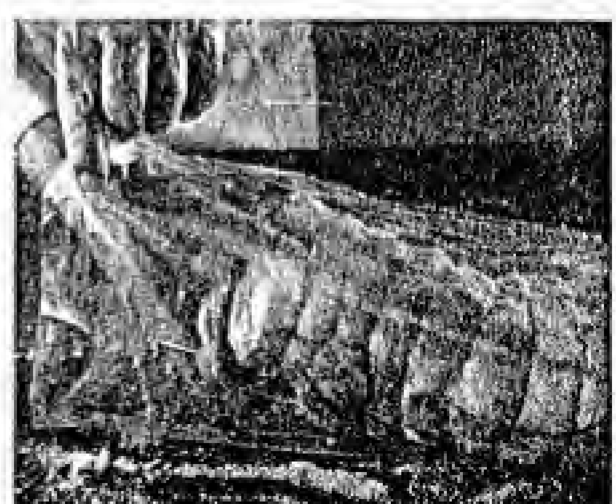
2. *Cut along ribs to backbone as close to the bone as possible; lift out boneless loin piece from the rib and back bones*

3. *Slice boneless loin exactly in half, rub and pat in special curing salt to cover the top surfaces of both pieces of meat*

4. *Fit loin pieces together so thin end overlaps the thicker one, with the facing salt-covered surfaces faced together*



5. *Tie the pieces together, starting in center; loop at 1-inch intervals. Tie lengthwise and knot at the crossings*



6. *Pat and rub curing salt all over outside edges of meat. Put into plastic bag, tie the end firmly and refrigerate*

meat. After the meat is cured and smoked, it still requires regular cooking before you eat it. In general, cook it within a few days (you would need a heavier cure and more complicated curing process to prepare hams and bacons to keep all winter).

CHEESE

A smoker with controls that provide very cool temperatures will allow you to add smoke flavor to some of your favorite cheeses. We had excellent results smoking Cheddar, loaf-type Edam, jack (especially aged dry jack), Tybo, and Swiss. You may find others you like equally well. Chunks of cheese not more than about 1 pound each are good size for smoking — the outside edges turn a golden brown and are especially smoky flavored. Simply put the cheese on a wire rack and smoke about 1 hour or until it is as smoky as you like.

SAUSAGE

You can add smoke flavor to link sausages or your own homemade sausages. Hang strings of the links from hooks at the top of the smoker and smoke at about 140° for about 2 hours — sausages should just begin to turn a golden brown color. Remove and refrigerate. Cook over low heat as you would regular link sausages.

ROASTING CHICKEN OR TURKEY

Prepare the bird as you would for roasting; salt lightly inside the cavity, truss the legs and wings. Set on a rack inside your smoker. Smoke at about 140° for 2 to 3 hours, or until the skin takes on a golden color. (Poultry is best just mildly smoked — too much smoke overpowers its flavor.) Remove and refrigerate immediately.

You can stuff the bird with dressing just before you cook it if you wish. Roast as you would a regular bird and for about the same length of time.

PORK SPARERIBS

Ribs take well to a full smoke flavor. If you have curing salt, you can sprinkle it lightly on both sides of the ribs for added flavor; put ribs in a pan and let stand in the refrigerator overnight. You may prefer to smoke ribs just as you purchase them from the market. Set them on a wire rack or hang them in your smoker; smoke at a temperature of about 140° for 3 or 4 hours. Refrigerate, or cook immediately using your favorite recipe for baked or barbecued spareribs.

BEEF TONGUE

Special curing salt gives additional flavor and appetizing red color to a smoked beef tongue. A white skinned tongue is preferable for its final appearance after smoking. Rub and pat in curing salt all over the outside of the tongue (we used about ¼ cup for a 4 to 5-pound tongue). Put into a plastic bag and refrigerate for about 10 days, turning over several times. After it is cured, wash the tongue well in warm water and dry thoroughly. Put into a smoker on a wire rack; smoke at about 140° for 4 hours or until richly colored.

WHOLE PORK HAM

To cure this large cut at home, we suggest you have it boned so the curing salt can be rubbed into the inside as well as outside of the piece. Ask your meat dealer to remove the long bone from a whole ham (about 12 pounds), cutting it apart at the ball joint to leave in the small shank bone; or you can bone it at home.

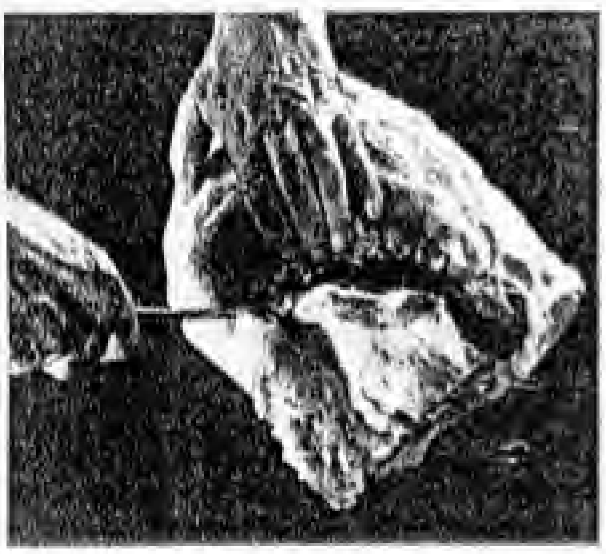
At home carefully rub curing salt into all inside surfaces of the ham and around the cut edges. Tie the boneless ham as shown in the photograph on page 126, then rub curing salt all around the outside of the meat — you'll need about ½ to ⅔ cup curing salt in all. Put the ham into a large plastic bag, tie the end, and refrigerate about 10 days. Turn meat over several times as it cures.

Wash the outside of the ham to remove curing salt; dry well. Hang inside your smoke oven and smoke at 140° for about 4 hours, or until it is a rich reddish color. Remove and refrigerate until you are ready to bake it. Bake as for a regular "cook-before-eating" ham, allowing about 18 to 20 minutes per pound (it should reach an internal temperature of 160° on a meat thermometer). Or cut thick slices to barbecue, broil, or sauté.

WHOLE PORK LOIN

A whole loin (about 12 pounds for a me-

WHOLE HAM . . . *boned and cured*



1. *To bone whole ham, lay fat side down; cut around the aitchbone and disjoint aitch from the straight leg bone*

2. *Cut around long leg bone to knuckle joint. Cut through knuckle, lift out leg bone, leaving the shank bone in place*

3. *Sprinkle with special curing salt; rub and pat in to cover all cut surfaces well. Tuck in any ragged meat pieces*

4. *Tie ham at 1-inch intervals, starting in center, working to ends. Tie lengthwise, knotting cord at the crossings*

dium-sized one) will yield about 5 to 6 pounds of boneless loin (Canadian bacon), and also a 2 to 3-pound pork butt, and a piece of boneless pork tenderloin (enough for about 4 servings) for you to slice and cook fresh. You could ask your meat dealer to remove the flat blade piece, cut off the pork butt and the tenderloin, then bone out the loin, or you can do this yourself following our directions (see photographs, page 124).

Cut the piece of boneless loin in half crosswise, and fit the pieces together with curing salt rubbed into facing surfaces. Tie securely as shown in the picture, to form a compact piece. Rub curing salt all over the outside, using a total of ½ to ⅝ cup. Put into a plastic bag, tie end tightly, and refrigerate for about 10 days to cure, turning several times.

Rinse the outside of the meat with warm water to remove curing salt; dry thoroughly. Hang the loin inside the smoke oven and smoke at about 140° for about 4 hours or until it is a rich, reddish brown. Refrigerate and cook within about a week. Slice thinly and sauté as you would Canadian bacon. Or bake a 2 to 4-pound piece for 1½ to 2½ hours (to internal temperature of 170°).

PORK BUTT

The butt end from the whole loin, weighing 2 to 3 pounds, can be cured and smoked at the same time as the loin. Rub special curing salt all over the outside—it will take about ¼ cup. Put into a plastic bag, tie end, and refrigerate to cure for 7 to 10 days, turning several times.

Wash the salt off the meat and dry well before smoking it. Smoke at about 140° for 3 or 4 hours, or until rich, reddish brown. Refrigerate until you cook it. Simmer in water to cover until tender, about 50 minutes per pound. Serve hot or cold. Or remove from water, cover with a sweet glaze and bake in a hot oven (400°) about 15 minutes.

BACON

The best part of the pork side for bacon is the brisket end, ask your meat dealer for the upper ⅔ of the side of pork—about 8 pounds for a medium-sized piece—and have skin removed. Sprinkle special curing salt on all sides of the piece, patting and rubbing it into the meat; it will take about ⅔ cup of the salt. Put into a large plastic bag and refrigerate about 10 days, turning several times (keep flat). Wash off salt and dry well. Hang in smoker and smoke at about 140° for about 4 hours or until the bacon is a rich golden brown. Refrigerate and slice to cook as desired.

FISH

Fat fish such as salmon, trout, or sablefish (also called black cod or butterfish) are best for smoking. Clean and dress. Small trout may be left whole; larger fish should be filleted or cut into steaks, not more than 4 inches wide. Cover fish with a brine, using ½ cup salt, ¼ cup sugar, 2 tablespoons pepper, 3 or 4 bay leaves (optional) to each 1 quart water. Allow to stand in the refrigerator for 4 to 6 hours (2 to 3 hours if fish has been frozen).

Remove from brine, rinse in cold water, and allow to stand at room temperature until dry and a film forms on fish. Place on racks in smoker and smoke at about 150° for 3 or 4 hours for small fish or pieces up to about 8 to 10 hours for largest sized pieces—or until you obtain the degree of smoking you prefer. Remove and refrigerate until used. It needs no further cooking.

INDEX

 THE SURVIVOR Vol. 6

TESTED RECIPES
from
EL MOLINO KITCHENS

BREADS & ROLLS

CAKES & PASTRIES

CASSEROLES

CEREALS

DRINKS

GLUTEN

HOT CAKES & WAFFLES

SOUP & SPROUTS

ALLERGY RECIPES

HELPFUL HINTS

RECOMMENDED DAILY DIETARY ALLOWANCES

COMPOSITION OF FOODS

EQUIVALENTS

Tbs = Tablespoon
tsp = Teaspoon
c = Cup

gm = Gram
mg = Milligram
lb. = Pound

"dash" = less than ⅛ tsp
60 drops = 1 tsp
3 tsp = 1 Tbs
16 Tbs = 1 c
2 Tbs = 1 liquid ounce
1 c = ½ pint
4 c = 1 quart
16 fluid ounces = 2 c
1 gm = 1000 mg
5 gm = 1 tsp
28 gm = 1 ounce
454 gm = 1 lb.
2 c water = 1 lb.
4 c flour = 1 lb.
2 c butter = 1 lb.
2 c granulated sugar = 1 lb.
2⅔ c brown sugar = 1 lb.
2⅔ c powdered sugar = 1 lb.
1 c honey = 3/4 lb.
1 c molasses = 13 ounces
2½ c raisins = 1 lb.
4 Tbs. Dry Yeast = 1 oz.
2 c dates = 1 lb.
3 c cornmeal = 1 lb.
4 c grated cheese = 1 lb.
1 c nutmeats = 5 ounces
1 c shortening = ½ lb.
1 c uncooked rice = 2 c cooked
8 to 10 egg whites = 1 c

12 to 14 egg yolks = 1 c

1 c white flour = 1 c unbleached white flour

1 c white flour = 1 cup Fine Whole Wheat Flour

1 c white flour = 1 c Pastry Whole Wheat Flour

1 c white flour = 7/8 c Stone Ground Whole Wheat Flour

1 c white flour = 2/3 c white flour and 1/3 c wheat germ (flake or flour)

1 c sugar = 1 c honey with 1/4 c less liquid

1 c sugar = 1/2 c honey and 1/2 c sugar with 1/8 c less liquid

1 c sugar = 1 c corn syrup with 1/3 c less liquid (not so sweet)

1 c sugar = 1 1/3 c maple sugar

1 c sugar = 1 c brown sugar or 1 c raw sugar (not so sweet)

1 egg is equal in leavening power to 1/2 tsp baking powder

It seems El Molino Mills are no longer in business. You will find several recipes calling for their special mixes. Since they are no longer available, don't give up on the recipe. Just use the nearest thing to it.

This book also deals wonderfully with the use of all sorts of grains and legumes not common. They are described at the end of the book and can be gotten at your local health food store.

A few things, such as sourdough, have been omitted since they do call for special mixes and are not that important to the subject.

GUIDE TO RECIPES

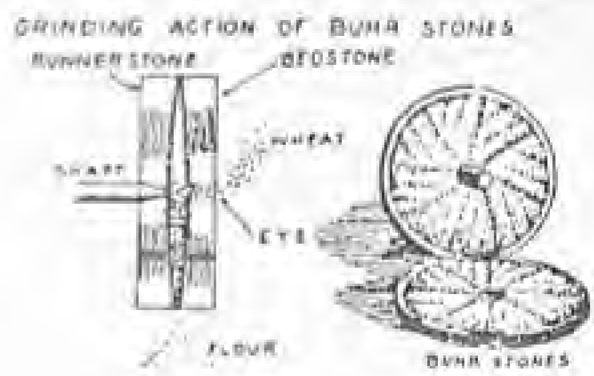
(To find where specific products are used in recipes, refer to listings under "Products Offered by El Molino Mills" following 900 series.)

BREADS & ROLLS

CAKES & PASTRIES

CAROB ICE CREAM

CASSEROLES



Breads and Rolls

BISCUITS & CRACKERS

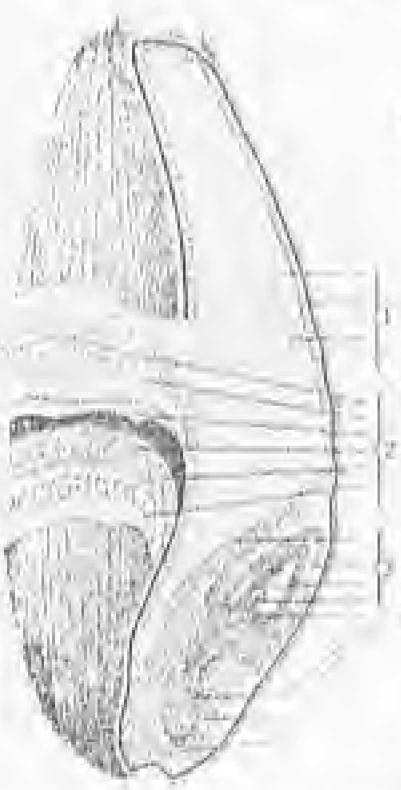
COFFEE CAKE

MUFFINS

WHEAT STICKS

SELECTED HIGH PROTEIN WHEAT USED BY EL MOLINO MILLS CONTAINS THESE ESSENTIAL MINERALS AND VITAMINS:

MINERALS		VITAMINS:
CALCIUM	IODINE	THIAMINE B-1
IRON	FLUORINE	RIBOFLAVIN B-2 or G
PHOSPHOROUS	CHLORINE	NIACIN
MAGNESIUM	SODIUM	PANTOTHENIC ACID
POTASSIUM	SILICON	PYRIDOXINE B-6
MANGANESE	BORON	BIOTIN or H
COPPER	BARIUM	INOSITOL
SULPHUR	SILVER	FOLIC ACID
And Other Trace Minerals		CHOLINE
		VITAMIN E
		Plus at least four other vitamin factors generally found in Bran and Wheat Germ.



1. The inner part of the whole kernel called the ENDOSPERM, consists mostly of starch and a small amount of protein. The Endosperm contains almost no vitamins or minerals. White flour is made from this part of the kernel, which is low in those nutrients upon which we depend for our health.
2. These are the BRAN layers, in which are found—
   Large amounts of VITAMINS
   Large amounts of MINERALS (iron to make good red blood and phosphorus for nerves and bones).
   PROTEINS of very good quality.
3. The EMBRYO, or "wheat germ". This is the life-giving part from which the wheat plant sprouts and is one of the richest known sources of B and E vitamins. It also contains valuable proteins and fat.

In white flour about one-half of the fat is lost. This fat has a high food value, since it contains unsaturated fatty acids and vitamin B1, all of which are nutritionally very important.

Slow oven	250 to 300° F.
Moderate	325 to 375° F.
Hot	400 to 450° F.
Very Hot	475° or more

☆ ☆ ☆

HEALTH BEGINS IN THE KITCHEN

"Whenever anyone asks me how to build up the health of a growing child, a convalescent, or an invalid, how to add more protein, calcium, iron or B vitamins to the diet, or simply how to have fun at cooking, my answer is, "Make your own breads." — Adelle Davis.
— From "Let's Cook It Right."

☆ ☆ ☆

Every detail is described in this proven method of baking delicious bread from El Molino Stone Ground 100% Whole Wheat Flour.

If all directions are carefully followed, your bread should have good flavor, grain and texture, moisture, volume, odor, color and can be sliced without crumbling.

As your individual technique improves you will find new variations to delight yourself and your family.

BEST WAY TO MOLD A PERFECT LOAF OF BREAD

1. Take each loaf separately and press or roll into a flat oblong sheet.
2. Take one long side and fold ⅓ of dough over and press with palm of hand to seal.
3. Fold the other long side, overlapping the first and press and seal as before.
4. From the end, fold ⅓ of dough over and press and seal.
5. Fold the other end overlapping the first.
6. Press again.
7. Roll the sheet of dough lengthwise, like a jelly roll, making a round compact loaf. Seal overlap.
8. Place in greased loaf pan with overlap underneath.

☆ ☆ ☆

WHOLE WHEAT BREAD 100

using EL MOLINO Stone Ground 100% Whole Wheat Flour

2 c milk	2 Tbs active dry yeast
3 Tbs oil or butter	5½ c unsifted whole wheat flour
1 Tbs salt	
½ c honey (clover preferred)	

Heat milk to simmer. Drop oil, salt and honey into simmered milk and pour into large mixing bowl. Cool to LUKEWARM.

Dissolve yeast in ½ c LUKEWARM water about 4 min. (To hasten yeast action, sprinkle with ½ tsp sugar). Add dissolved yeast to mixture in bowl.

Add 3 c flour. Stir 8 minutes with electric mixer at low speed; or, 300 strokes by hand. Add 2 c flour* and stir well.

Turn on to floured board and knead until dough is smooth and elastic, kneading in more flour if necessary.

(Thorough kneading develops gluten which is essential to good texture and volume.)

Place in oiled bowl, cover with towel and let rise in a warm place until double in bulk. (80° to 85° F. for about 1 hour)

Knead down to original size, cover and let rise again.

Knead down to original size, cut in half, shape into two loaves, place in oiled bread pans, cover with towel and let rise until dough begins to lift towel.

Place to bake in 375° F. preheated oven for 45 minutes, or until golden brown.

Remove from pans and place on wire rack to cool.

If soft crust is desired, brush with cream or soft margarine.

Volume of loaves is sacrificed if dough is allowed to rise too high in pans. Allow ⅓ of rise to take place in baking.

Variations: 100A

*1 to 2 cups of this flour may be replaced with: wheat germ, soya flour or meal, rye flour or meal, carob powder, cooked cereals, scotch oatmeal, potato flour, corn flour or meal, or unbleached hard white flour, etc.

Remember this rule: 100B

The success of adding desired wheat germ, cracked grains, soya flour, sprouts, etc., to breads lies in an important rule:

Develop the gluten in the wheat flour by mixing thoroughly before adding the other desired grains.

Only WHEAT contains any appreciable amount of gluten. Gluten is necessary for an even rise and a desirable texture, grain, volume, etc. Gluten in the wheat is carrying the "load" of the other additions — so develop the gluten first.

In cases where quite a little wheat flour is replaced with other desired ingredients, add a little pure Gluten Flour at the first mixing. This helps to "carry the load" which you intend to add later.

Sometimes it is best to punch down only once before shaping the dough for the pans.

Moist additions such as, sprouts, cooked or soaked grains may be added at the time of the final kneading — just before shaping for the pans.

Variations: 100C

Replace 2 Tbs per c flour with Soya Flour, using slightly more liquid. Increases keeping qualities of the bread.

More Soya Flour can be used in place of wheat flour by replacing additional wheat flour with Gluten Flour. Various ratios may be used successfully. Try 3½ c Whole Wheat Flour or Unbleached White Flour, or, a mixture of both: 1½ c Soya Flour and ½ c Gluten Flour.

Replace 1 to 3 c flour with about the same amount of any combination of the following products Brown Rice Flour, Rice Bran, Rice Polish, Corn Meal or Corn Flour, Soya Flour or Soya Meal or Wheat Grits, Barley Flour, Scotch Oatmeal, Flaxseed Meal, Sunflower Seed Meal, Millet Meal, Potato Flour, Carob Powder, Muffin Mix.

For a "crunchy" texture, mix in a few Tbs. Cracked Wheat, Rye Grits or Soya Grits. For softer bits, pour boiling water over grits and let stand an hour or so.

Sprinkle board with Hulled Sesame Seed and roll dough in seed before placing dough in pans.

Replace 1 to 3 c flour with left-over cooked cereals.

Replace 1 c flour with 1 c Bran, or Wheat Germ and Middlings adding a few raisins or chopped nut meats.

After the first rise, knead in a cup of sprouted Wheat or sprouted Alfalfa Seed which has been run thru a meat grinder.

Variations: 100D

RYE BREAD: Replace about 2 c flour with 2 c Rye Flour or part Rye Meal, adding 2 or 3 Tbs caraway seeds; or, 1 tsp anise seeds. Dark or blackstrap molasses may be used, instead of honey.

BREAD BAKING HINTS 100E

Before dissolving yeast in lukewarm water, test temperature by dipping your bare elbow: 90° to 115° F. temperature is desirable. If yeast action begins within a few minutes it is fit to use. Dissolve thoroughly.

Yeast in cakes must be fresh. Packaged live, dry granulated yeast is more dependable. El Molino yeast assures baking success.

Always bake bread in an oven that has been pre-heated at least 5 minutes before placing bread inside.

To obtain a more even rise in loaf, place dough in pans so that ends snugly touch ends of pan.

During dry weather, lightly sprinkle towel covering rising dough with lukewarm water.

If stirring mixture by hand, the longer you stir the dough the more you develop the gluten in the flour and the more elastic it will become and the lighter the bread will be.

Brush dough in pans with beaten egg or milk before sprinkling with Hulled Sesame Seeds, Cracked Wheat, Rye Grits or Wheat Germ.

Before kneading dough, grease or flour hands well to avoid sticking.

PEPTIC ULCER & COLITIS sufferers in some cases believe that finely ground bran such as appears in medium stone ground whole wheat flour is an irritant.

Bran is nature's protective covering and is naturally somewhat water repellent. To provide you with all the rich minerals of the wheat bran we finely grind all the bran in with the flour. Naturally a flour can't be truly 100% without this important part of "Nature's complete package".

Here is an excellent remedy . . . just soften the bran. Softening of the bran may be accomplished simply by allowing the wet bread mixture (except for the yeast) to stand overnight. Keep the dough mixture wet and do your dusting with unbleached white flour instead of with whole wheat flour.

DRY AND CRUMBLY BREAD problems can be overcome with the above method and your dough will be more elastic resulting in bread of better texture and more volume through a more complete development of the gluten.

Tip: For an easily cooked cereal where bran is thoroughly softened, try #404.

CORNELL TRIPLE RICH BREAD 101

FAMILY RECIPE

(Also called Cornell Bread and High Protein Bread)

This makes 3 loaves

PLACE in a large bowl, and LET STAND for five minutes.

3 c warm water (85° F.)
2 packages of yeast (compressed or dry active)
2 Tbs brown sugar

In the meantime, MEASURE and SIFT together:

6 c sifted unbleached enriched bread flour (containing wheat germ or add 3 Tbs wheat germ with the flour)
½ c stirred full fat soya flour
¾ c non-fat dry milk solids (dry skim milk)

STIR the yeast mixture and ADD while stirring:

4 tsp salt

Half the flour mixture

BEAT vigorously (about 75 strokes or 2 minutes with electric mixer. ADD:

2 Tbs oil and remainder of flour mix.

STIR flour in thoroughly, and when all is incorporated turn dough out on floured board, using one cup more flour if needed. Knead vigorously, about 5 minutes until the dough is smooth and elastic. Place in a greased bowl, grease top of dough lightly and cover bowl. Let rise in a warm place, 80 to 85° F. until nearly double in size, about 45 minutes.

PUNCH dough down, fold over edges and turn upside down in bowl to rise another 20 minutes.

TURN onto board, and divide dough into three portions. Fold each in to the center to make smooth tight balls. Cover with a cloth and let stand 10 minutes on the board.

SHAPE into 3 loaves, or 2 loaves and a pan of rolls. Place in greased tins. Loaf tins should be about 3½ x 7½ inches in size. Let rise in tins until dough is double in size, about 45 minutes.

BAKE in a moderate oven, 350° F., for about 50 minutes. If the loaves begin to brown in 15 or 20 minutes, reduce the temperature to 325° F.

REMOVE the bread from the pans and put on a rack or cloth to cool. Brush with melted butter if desired.

The amount of time needed for yeast dough to rise depends a great deal on the temperature. On a cool day, more time will be needed than we have indicated in this recipe. In bread-making, practice makes perfect.

You can make other "Triple Rich" baked products, such as cakes and cookies containing better quality protein, more minerals and vitamins with your own favorite recipes. The only change needed is to put 1 Tbs of soya flour, 1 Tbs of dry milk and 1 tsp of wheat germ in the bottom of the cup when you measure each cup of flour and there you are!

NOTE:

El Molino offers Unbleached White Flour, milled from hard, hi-protein wheat which results in excellent results when baking yeast doughs.

This flour may also be used for pastries requiring softer wheats just by sifting several times to lighten the texture.

Enrich with the desired amount of wheat germ. (2% of 100% wheat consists of wheat germ. Replacement of this amount restores to white flour the germ removed in the refining of the wheat.)

SESAME BREAD 101A

2 Tablespoons sesame seed	½ cup butter
1 large loaf French bread	¼ cup finely chopped parsley
	¼ cup finely chopped chives

Slice bread lengthwise. Combine butter, parsley and chives and spread on cut surfaces of bread. Sprinkle with sesame seed and bake in a moderate oven (350°) for 20 minutes or until loaf is crisp. Serves 6.

CHRISTMAS (or EASTER) STOLLEN 101B

using EL MOLINO STONE GROUND WHOLE WHEAT BREAD MIX

3 lbs Bread Mix (includes 3 pks. dry yeast)	½ c honey
1 c powdered skim milk	1 c vegetable oil
6 eggs	Plus amount to suit taste; glazed, chopped mixed fruits, raisins, walnut meats, lightly toasted hulled Sunflower seeds.

Dissolve 3 pkgs. yeast with ½ c lukewarm water in small bowl (keep warm). In very large bowl combine 3 lb. bag Bread Mix with 1 c powdered skim milk, remove 2 cupsful. In another bowl beat eggs, add honey, oil and 2 c lukewarm water. Add both bowls containing liquids to very large bowl of dry mix. Mix well and then gradually stir in 2 cupsful of dry mixture which was removed. (This enables you to stir more easily and more completely develop the gluten in the wheat.)

Cover bowl with tea towel and let rise until doubled in volume. Stir down and turn on to floured board and knead until dough is smooth and elastic — kneading in more flour if necessary. Knead in glazed, chopped fruits, raisins, walnut meats, sunflower seed in whatever amounts preferred. The more fruit, the richer and sweeter the bread. When fruit is well distributed through the dough, cover and let stand on board until almost double. Punch down and form into six long slender loaves. Place on cookie sheets and allow to rise again until almost double. Bake at 350° F. in preheated oven for about 40 minutes, or until well browned. Place on wire rack to cool. (If soft crust is desired, brush with cream or soft margarine.)

(This recipe (without the fruit and nuts) is a good basic dough for any kind of coffee cake, raised doughnuts, cinnamon or orange rolls. Grated lemon or orange peel may be added for extra flavor.

FOR EASTER STOLLEN — omit fruits and nuts and add 4 Tbs. anise seed.

DUTCH RYE BREAD (BRICKS) 105

4 c Rye Meal (Pumpernickel)	2 Tbs Oil
1 c Wheat Grits	1½ tsp salt
2 Tbs Honey	3⅓ c boiling water
	¼ c Bran

Method: Mix all ingredients in a mixing bowl. Cover, and let stand overnight (room temperature).

The following morning, shape loaf and roll in bran (or wheat germ, flaxseed meal, etc.)

Bake in covered pan for 4 hours in slow oven—200° F. Place another pan of hot water in oven to keep oven moist. After cooling, wrap in towel and keep in refrigerator to prevent drying or moulding.

SWEDISH LIMPE 106

(Slightly Sweet rye bread) — Mrs. H. K. Carter

4 c water	1 Tbs active dry yeast
½ c molasses	6 c whole wheat flour
1½ Tbs caraway seed	2 tsp salt
2 Tbs oil	4 c rye flour (approximately)
2 tsp chopped orange peel; or 1 tsp anise seed	

Boil together in large kettle for three minutes: water, molasses, caraway seed, oil and chopped orange peel (or anise seed). Cool to LUKEWARM. Add yeast to dissolve. Add 6 c whole wheat flour to make a soft dough.

Let rise in warm place for 1½ hours. Add salt and about 4 c rye flour kneading in to make a stiff dough.

Let rise again for 2 hours. Knead slightly and shape into 3 loaves and place in oiled bread pans.

Let rise in pans ½ hour and bake at 350° F. for 45 minutes.

WHOLE WHEAT SOYA BREAD 107

Sponge Method

1 Tbs active dry yeast	⅔ c Whole Wheat Flour
½ c lukewarm water	

Sponge: Soften yeast in water, add flour to make soft batter, let rise ½ hour until light.

½ c oil	2½ tsp salt
⅓ honey (or brown sugar)	2 c lukewarm water

Pour the warm water over oil, add other ingredients, then add to the sponge and beat at low speed with electric mixer.

1⅓ c Unbleached White Flour	4 to 5 c Whole Wheat Flour
½ c Soya Flour	

Sift together and add to above using electric mixer until ½ the flour has been added. Work in the rest of the flour, turn out onto floured board and knead well.

When dough is smooth and elastic, place in oiled bowl, let stand in a warm place until double in bulk.

Punch down, and put in pans to rise. Bake at 350° F. for about 45 minutes.

When the recipe is doubled, you will get five 1¾ # loaves. Cool on wire racks and place a few loaves in wax bags and freeze.

SOYA BREAD 107A

Mrs. Horton Churchill

4½ c Unbleached White Flour	3 tsp salt
1½ c Soya Flour	2 Tbs active dry yeast
¾ c Dry Skim Milk	2 c warm water
2 tsp dark brown sugar	2 eggs
	6 Tbs oil

Sift unbleached white flour and soya flour together, resift with skim milk, sugar and salt. Dissolve yeast in ½ c warm water. When dissolved add 2 c warm water, lightly beaten eggs and oil. Add to dry ingredients and mix thoroughly. Turn out on floured board and knead well and then let dough rest 15 minutes. Knead for 10 or 15 minutes, mold into two loaves and put in well greased pans and let rise until almost double in bulk. Bake in pre-heated oven 375 degrees for 35 minutes.

This same recipe will make 36 rolls and 1 loaf of bread if desired.

WHOLE WHEAT GLUTEN BREAD 108

Kitchen tested for perfect LO-Calorie bread in 2½ hours.
Hi-Protein — Lo-Starch

2 Tbs El Molino Active, dry yeast (or 2 yeast cakes)	2 c gluten flour
½ c honey (clover preferred)	1 qt. water, or potato water #108A
6 c unsifted whole wheat flour	¼ c oil
	1 Tbs salt
	1 Tbs brewers yeast (optional)

In a large mixing bowl, dissolve yeast in 1 qt lukewarm water and honey. Stir yeast until dissolved. Add 4½ c whole wheat flour and 1 c gluten flour. Mix well, cover with a sheet of waxed paper and a towel and place in warm place to rise.

When double in size, stir in oil, salt, (brewers yeast), 1 c gluten flour and about 1½ c whole wheat flour — enough to make a firm dough. Knead about 10 minutes on well floured board, place in bowl, cover and let rise until double in size again.

Return to well-floured board, lightly work down and shape into 2 large, or 3 small loaves. Bake at 350° F. for 1 hour.

POTATO WATER 108A

In place of using freshly cooked mashed potatoes we suggest potato flour which is quickly made and always uniform:

Use 1 part potato flour to 4 or more parts of milk.
Use a beater to make a smooth consistency.

This practical and inexpensive method is used to condition doughs and improve the flavor of baked goods.

LO-CALORIE GLUTEN BREAD 109

By using Gluten Flour for your baked products you can cut down your intake of starch calories considerably. Gluten flour is government standard (not less than 40 per cent protein nor more than 44 per cent starch). You will find the following recipe easy to prepare and really palatable.

1 c Water	½ tsp Salt
2⅓ c Gluten Flour	1 Tbs active dry yeast

Put the yeast to soak in two additional Tbs of warm water. When softened add rest of water and salt. Add the flour and knead thoroughly for 10 to 15 minutes. Mold. Let rise at room temperature until doubled in bulk. Bake in moderate oven (350° F.) ¾ to 1 hour. Makes a pound loaf. One 30 gram slice provides: Protein 6.5 grams; Fat none; Carbohydrates 7.5 grams; 56 Calories.

OATMEAL SUNFLOWER GLUTEN BREAD 110

Ethel B. Spear

2 c rolled oats	1 c raisins
½ tsp salt	¾ c Hulled Sunflower Seeds
2 Tbs active dry yeast	½ c gluten flour
½ c molasses	5 c Unbleached White Flour (about)
1 Tbs butter or oil	

Pour 2 c boiling water over rolled oats and salt and let stand for one hour. Dissolve yeast in ½ c lukewarm water and add to scalded oats. Add remaining ingredients and knead in enough flour to make a smooth, elastic dough. Let rise to double in bulk—knead down and let rise again until double in bulk. Knead down again, shape into loaves, place in oiled bread pans. Cover with cloth and let rise until it begins to lift cloth. Bake in pre-heated oven at 350° F. for about 1 hour until done.

BANANA NUT BREAD 111

Another prize winner by — Christine Jakubecy

⅓ c oil	2 c Whole Wheat Flour, or Pastry Whole Wheat Flour
1 c brown sugar	1 tsp soda
3 eggs	1 tsp vanilla
1 tsp salt	1 c chopped nuts (coarse)
⅔ c milk	
4 ripe bananas	

Cream sugar and oil, add eggs and bananas. Sift dry ingredients together and stir into banana mixture adding alternately with milk and about 3 Tbs cold water. Add vanilla and nuts. Bake at 350° F. for 1 hour.

POTATO BREAD AND ROLLS 112

1½ c milk (lukewarm) 1 Tbs active dry yeast

Dissolve yeast in lukewarm milk.

Then add:

1 Tbs salt 1 Tbs sugar
1 Tbs oil

Then add:

4 c Unbleached White Flour or Whole Wheat Flour ¾ c Potato Flour

Blend together and mix into smooth dough. Let rise about 2 hours, then fold dough over. Let rise 15 minutes the second time. The dough is now ready to be made into loaves, or rolls. Bake at 375-400° F. about 35 minutes.

BUTTER HORN ROLLS 113

Christine Jakubecy

1 Tbs active dry yeast	½ c oil
1½ tsp salt	¼ c brown sugar
4½ c whole wheat flour (approximately)	3 eggs (well-beaten)
	1¼ c milk

Soften yeast in lukewarm milk, add salt, oil, sugar, and eggs. Slowly add flour, beating thoroughly.

Knead until elastic and let rise twice before making rolls. Roll dough out to a circle of 12 inches (in diameter) and spread melted butter over dough. Cut in 16 pie-shaped pieces and roll up. Let rise until double in size and bake at 400° F. for 15 to 18 minutes.

PARKER HOUSE ROLLS 114

La Ree McCauley

1 c warm milk	6 Tbs butter or oil
1 egg	¼ c honey or brown sugar
1 Tbs active dry yeast	1 Tbs salt

dissolved in LUKE-WARM water
2 c whole wheat flour

Add ingredients to 2 c whole wheat flour. Beat well and add enough more flour to make soft dough. Knead well.

Roll the dough about 1 inch thick and cut with a biscuit cutter. Over half the round spread melted butter and fold over the other half. Cover and let rise in warm place until double in bulk. Bake at 400° for about 15 to 20 minutes. Makes 18 rolls.

OLD TIME CORN BREAD 115

1⅓ c corn meal	1 tsp salt
⅓ c unbleached white flour*	1 egg
3 tsp baking powder	1 c sweet milk
	¼ c oil

Sift together all dry ingredients. Add beaten egg, milk and oil. Stir just enough to moisten. Pour into greased pan. Bake at 400° F. 30 minutes.

Variation:

Replace sweet milk with buttermilk or sour milk using 2 tsp baking powder and 1 tsp soda.

*It is not necessary to use flour to prevent crumbling, since El Molino 100% Stone Ground corn meal contains all the corn germ and corn flour. White flour may be replaced with corn meal if desired.

"SWELL" CORN BREAD 115B

Mother Vandercook

2½ c El Molino Corn Meal	3 Tbs oil
½ tsp soda	2 beaten eggs
1 tsp salt	2 c buttermilk

Combine dry ingredients. Add beaten egg and oil to buttermilk. Stir in dry ingredients and beat to a smooth batter. Bake in well-oiled pan (9x9") and bake 35 min. at 400°.

CORN BREAD 116

a la Mrs. W. M. Corrigan

Group 1	Group 2
1 c Corn Meal	2 eggs
1 c Unbleached White Flour	1½ c buttermilk
⅓ c Wheat Germ	2 Tbs brown sugar
2 Tbs Rice Polish	⅓ c oil or bacon drippings
1 tsp salt	
¾ tsp soda	
1 tsp baking powder	

Mix all ingredients in group 1 in bowl with a fork.

Add beaten egg to buttermilk and sugar and add to group 1. Mix until smooth and add oil. Bake in well-greased pan 8x8x2 inches at 425° F. for 30 to 35 minutes.

CARROT CORN BREAD 117

Ida Mae Henderson

1 c corn meal	1 tsp salt
1 c grated carrots	2 Tbs oil
1 Tbs brown sugar	2 eggs

Mix thoroughly in mixing bowl: corn meal, carrots, oil, sugar and salt. Stir in ¾ c boiling water.

Add 2 Tbs cold water to 2 egg yolks and beat until thick and add to mixture above. Fold in stiffly beaten egg whites. Pour into a warm, oiled pan and bake at 400° F. for 25 minutes or until done.

ARKANSAS CORN PONE 118

1 c sour milk	1 Tbs brown sugar
1 c Stone Ground Corn Meal	1 scant tsp salt
2 eggs	1 scant tsp soda
1 Tbs oil	

Stir and beat until thoroughly mixed. Pour into sizzling hot pan, well greased. Bake 15 minutes at 450° F. Then 30 minutes at 300° F.

SOUTHERN SPOON BREAD 119

4 c milk	1 tsp salt
1 c Stone Ground Corn Meal	2 Tbs brown sugar
3 eggs	1 Tbs melted butter or oil

Bring milk to boiling point, add corn meal. Let cool 10 minutes. Beat egg yolks and add salt, sugar and melted butter. Add this to mixture. Fold in stiffly beaten egg whites. Bake in greased baking dish at 350° F. for 30 minutes.

You haven't eaten muffins, hot cakes or waffles until you've tried

DELICIOUS QUICK MUFFINS 120

1 Tbs oil	1 c Buttermilk (or milk)
1 egg	1½ c Muffin Mix

Beat egg thoroughly. Stir in ½ c Muffin Mix and oil. Add remaining Muffin Mix and milk alternately. Mix well. A thick batter assures dry texture. Bake in well-greased muffin tin at 375° F., 30 to 40 minutes. Dates, nuts or raisins may be added if desired. Yields 6-8 muffins.

HOT CAKES AND WAFFLES 121

Mix same as for Muffins using slightly less milk. Make thick batter and spoon on to medium hot griddle. For best results, make small hotcakes (3 to 4 inches across).

WHOLE WHEAT MUFFINS 122

1⅔ c Whole Wheat Flour	1 egg, beaten
2½ tsp Baking Powder	1⅓ c sweet milk
3 Tbs brown sugar	4 Tbs oil
1 tsp salt	

Mix together the whole wheat flour, brown sugar, baking powder and salt. Beat egg until light, add milk and oil. Toss in the whole wheat flour mixture and stir quickly just enough to dampen the flour. Let stand a few minutes until mixture thickens, then drop by spoonfuls into muffin tins and bake 425° F. 20 to 25 minutes.

Hulled Sesame Seed, Hulled Sunflower Seed, raisins or nuts may be added to the mixture or sprinkled on top of muffins before placing in oven. A small spoonful of jam or jelly may also be placed on each muffin.

WHEAT GERM MUFFINS 123

Without baking powder

Ethel B. Spear

1½ c milk	1½ c Whole Wheat Flour
½ c oil	1 c Wheat Germ
1 tsp salt	2 eggs
1 tsp brown sugar	

Separate eggs. Beat yolks and add salt, sugar and oil. Stir in milk adding flour and wheat germ. Fold in stiffly beaten egg whites. Bake in hot, well-oiled gem pans at 350° F. for about 40 minutes.

WHEAT GERM MUFFINS 124

1 c Wheat Germ	1 c Whole Wheat Flour
4 Tbs brown sugar	¾ tsp salt
1 egg	1 c milk
4 tsp baking powder	2 Tbs oil

Mix milk and well beaten egg in bowl. Add wheat germ. Let mixture stand a minute or so, until wheat germ absorbs some moisture. Sift in flour, salt, baking powder, sugar. Mix well. Add oil, and stir. Half-fill greased muffin tins. Bake in pre-heated oven at 400° F. for 20 to 25 minutes.

BRAN MUFFINS 125

1 c El Molino Whole Wheat Pastry Flour	½ tsp Salt
1 c El Molino Bran Flakes	3 Tbs Honey
4 tsp Baking Powder	3 Tbs Oil
	1 Egg
	1 c Milk

Sift, then measure flour; add baking powder, salt and Bran Flakes. Beat egg, add honey, oil and milk. Stir in dry ingredients, stirring only enough to mix. Fill greased muffin tins ⅔ full. Bake at 425 degrees for 15 minutes. (For variation a cup of raisins may be added.)

RICE AND WHEAT FLOUR BISCUITS 126

½ c Pastry Whole Wheat Flour
⅓ Brown Rice Flour
⅓ tsp salt
1 tsp baking powder
1 Tbs butter
1 Tbs oil
1 tsp honey
⅓ c plus 2 Tbs milk

Sift the dry ingredients together, and cut in the butter, add oil. Make a very soft dough with the milk and honey and form into biscuits. Bake on a greased cookie sheet in a very hot oven, 475° F. for 15 to 18 minutes.

SUNFLOWER BISCUITS 127

½ c Hulled Sunflower Seed Meal
½ c Pastry Whole Wheat Flour
1½ tsp baking powder
¼ tsp salt
3 Tbs oil
½ c milk (about)

Measure and sift the dry ingredients. Add oil and enough milk to make soft but firm dough. Drop from a spoon onto a greased, floured pan and bake at 375° F. about 12 minutes.

Hulled Sunflower Seed Meal mixes to advantage with flour in most all bakings. A characteristic of it is its quick baking, and in soup, it needs only just heating.

WHEAT AND DRY SKIM MILK BISCUITS 128

2 c Whole Wheat Pastry Flour or Whole Wheat Flour
4 tsp baking powder
1 tsp salt
½ c dry skim milk
⅓ c oil

Sift all dry ingredients together twice. Combine oil and ⅔ c water and add to dry ingredients. Mix as little as possible. Turn out onto lightly floured board. Pat out to ½ inch thickness and cut with floured cutter. Bake at 400° F. about 14 minutes.

WHEAT STICKS 129

Nellie James

1 c Unbleached White Flour
3 c Whole Wheat Flour
1 c Graham Flour
1 c Wheat Germ
2 heaping Tbs Soya Flour
½ c brown sugar or honey
¾ c oil
1 tsp salt
1 c coconut (optional)

Mix dry ingredients with enough water to make a very stiff dough (about 1¼ c).

Work in oil as for a pie crust. Add water to make a very stiff dough and knead until smooth. Roll to about ¼ inch in thickness, cut in sticks and bake in moderate oven until brown. (turn if necessary for even color).

WHOLE WHEAT STICKS 130

Mary Alexander

8 c (2 lbs.) W. W. Flour
2 tsp salt
¼ to ⅓ c sugar Brown
1⅓ c salad oil
1¾ c water

Mix dry ingredients in large bowl. Put oil in another bowl, add water slowly, beating with rotary beater till mixture is creamy. Mix dry ingredients and oil mixture and knead several minutes like yeast bread. Divide into several portions, roll into long rolls, flatten with rolling pin and cut in sticks. Bake in moderate oven until brown.

SUMMER SWEDISH RYE BREAD 131

3 c unbleached white flour
3 c rye flour
2 Tbs active dry yeast
1½ c water
3 tbs dark brown sugar
2 Tbs molasses
⅓ c oil
2 Tbs grated orange peel
2½ tsp salt
2 tsp caraway seed
1 tsp anise seed

Dissolve yeast in warm water, stir in brown sugar, molasses and rye flour, beat until smooth. Cover tightly and let rise in warm place until doubled in bulk. Stir in oil, orange peel and seeds, mix well. Gradually add 2¾ c of the unbleached white flour, beating vigorously. Cover and let set for 10 minutes. Sprinkle remaining ¼ c of flour on board and knead it in. Leave on board, cover with towel and let rise again until doubled. Shape into loaf, put into well greased bread pan, let rise until dough is slightly rounded above pan. Bake for about 45 minutes in 375° oven. This recipe makes one large loaf or two small ones.

CHEESE & ONION BREAD 132

El Molino

To a 3-lb. bag of STONE GROUND WHOLE WHEAT BREAD MIX
or
UNBLEACHED WHITE BREAD MIX
add: 1 lb. Cheese (grated)
½ oz. Onion Powder

HERB BREAD 133

El Molino

To a 3-lb. bag of STONE GROUND WHOLE WHEAT BREAD MIX
or
UNBLEACHED WHITE BREAD MIX
add: ¼ oz. Caraway
¼ oz. Nutmeg
½ oz. Sage

Follow directions with bag.

WHOLE WHEAT CRACKERS 134

2 c El Molino Stone Ground 100% Whole Wheat Flour
2½ tsp. Seasoned Vegetable Salt
5 Tbs Soy Oil
¾ c Water

Combine, flour and salt. Add oil and mix thoroughly. Stir in water, mixing well. Roll very thin on floured board. Sprinkle with Sesame Seeds, rolling seed in lightly. Bake at 425 Degrees for 8-10 minutes.

Gluten Sesame Thins (Crackers)
(See Gluten Section #614)

ANNE'S HEALTH BREAD 135

Anne Mitchell

2 Tbs Active dry yeast
1 c Rolled Oats
2 tsp salt
2 Tbs oil (safflower seed or soy)
1 c Raisins
1 c Bran flakes
½ c Molasses
¼ c Honey
1 c Wheat germ
½ c Flaxseed meal
3 c Whole Wheat Flour
2½ c Unbleached White Flour
½ c Chopped Almonds (optional)

Soften yeast in ½ cup warm water.

Mix bran flakes, oats, salt, oil, raisins in 2¾ cups boiling water. Cool to lukewarm.

Stir in softened yeast, honey and molasses. Stir in wheat germ, flaxseed meal, nuts (optional), and whole wheat flour.

Add enough unbleached white flour to make a smooth dough. Amount varies.

Knead four or five minutes, adding unbleached white flour as needed.

Place in bowl and grease top of dough.

Cover and let rise in warm place until double (about one hour). Punch down; divide dough in half. Place in 2 greased 9½x5x3" loaf pans.

Let rise until double, about 45 minutes.

Bake at 350° for 55 to 60 minutes.

How to make your favorite recipes more nutritious

Anne Mihaylo

WHOLE WHEAT CHIFFON CAKE 200

before CHIFFON CAKE	after WHOLE WHEAT CHIFFON CAKE (1)
2¼ c flour	2¼ Whole Wheat Pastry Flour
1½ c sugar	1 c brown sugar
3 tsp baking powder	½ c powdered skim milk
1 tsp salt	3 tsp baking powder (double acting)
½ c oil	1 tsp salt
8 unbeaten egg yolks	
¾ c cold water	
2 tsp vanilla	

grated rind of 2 lemons
8 egg whites
½ tsp cream of tartar

(2)
½ c oil
8 egg yolks
¾ c skim milk or orange juice
2 tsp vanilla
grated rind of 2 lemons (or oranges)

(3)
8 egg whites
½ tsp cream of tartar

(1) the cake is mixed in the standard way. Sift all dry ingredients together. (2) Add second group of ingredients and beat until smooth. (3) Fold in beaten egg whites last and put in large tube pan. Bake at 350° F. for 1 hour. Makes a large cake.

Variations: **200A**

Replace 1 c Whole Wheat Pastry Flour with 1 c Carob Powder. Or, replace 1 c Whole Wheat Pastry Flour with 1 c El Molino Muffin Mix.

Replace white flour in recipe with an equal amount of Pastry Whole Wheat Flour.

Replace white sugar with dark brown sugar; or, with same amount of honey using slightly less liquid.

Replace about ½ c sugar with ½ c powdered skim milk.

In any recipe calling for chocolate, replace with Carob Powder; also, replace about ⅓ of the flour with Carob Powder.

Grated lemon rind adds flavor to cakes with Carob Powder.

Replace ⅓ to 1 c flour with any of the following: Wheat Germ Flour, Wheat Germ, Soya Flour, Brown Rice Flour, Hulled Sunflower Seed Meal, El Molino Muffin Mix, Rice Polishing, Rice Bran, etc.

In all kinds of Carob Powder cakes and spice cakes the replacement of 5% of the wheat flour with Potato Flour greatly improves the taste and texture of the cakes and keeps the cuts from becoming dry. Soya Flour has the same effect.

CHAMPION FRUIT CAKE 201

3 times a FIRST PRIZE WINNER at Fairs
Christine Jakubecy

This recipe is as good the next day . . .
as it is months away.

1 c raisins
1 c dates
2 c brown sugar
½ c figs
5 Tbs butter or margarine

Combine with 2 c boiling water and let simmer over low fire ten minutes. Cool.

2 tsp cinnamon
1 tsp cloves
1 tsp soda
1 tsp salt
3 c Whole Wheat Flour or Pastry Whole Wheat Flour

Sift all dry ingredients with flour 3 times.

Add:
1 c chopped pecans
1 c chopped walnuts
1½ c mixed candied fruit
½ c candied cherries

Combine with cooled first mixture. Stir well. Place in pan which has been well greased and lined with greased paper. Decorate top with candied pineapple slices, cherries, shelled nuts, blanched almonds, etc. Bake at 300° for 2 hours or until done. Makes a 4½ pound fruit cake. For smaller fruit cakes bake about 1 hour and 20 minutes. Will stay moist a long time covered with a damp cloth.

SOYA - APPLESAUCE 201B

1½ c El Molino Pastry Whole Wheat Flour
¾ c El Molino Soya Flour
½ c Powdered Skim Milk
4 tsp Baking Powder
1 tsp Salt
2 tsp Cinnamon
½ c El Molino Wheat Germ
1 c Dark Brown Sugar
½ c Oil
4 Eggs
¾ c Applesauce
1 c Raisins

Sift dry ingredients except wheat germ: Cream sugar, oil and eggs. Mix dry ingredients with wheat germ and add to creamed mixture alternately with applesauce. Beat well. Turn into greased 12" x 8" pan and bake at 350 F. 40-45 minutes.

WHOLE WHEAT SPONGE CAKE 202

(egg leavened)
Mary Alexander

4 eggs separated (room temperature)
½ c cold water
⅓ c oil
1 c brown sugar
1⅓ c Pastry Whole Wheat flour
1¼ tsp lemon flavoring
¼ tsp salt

Beat egg yolks adding the cold water in about three dashes, also salt. Beat until light and stiff. Add sifted sugar gradually, then oil and flavoring. Fold in sifted flour, then the stiffly beaten egg whites.

Bake in an unoiled tube pan 250° F. for 15-20 minutes or until cake has risen, then increase heat to 350° F. to finish baking. Invert to cool.

This cake may be varied by using nuts, or fruits in it. It may be baked in a tube, layer, loaf or gem pans.

CAROB SPONGE CAKE 202A

Mrs. Jean Cross

3 large eggs (separated)
1 c CAROB POWDER
¼ tsp oil of peppermint

Beat whites of eggs until stiff. Flavor to taste with oil of peppermint. Beat yolks and fold into the whites. Fold in sifted CAROB POWDER. Bake at 300° for 45 minutes. Caution: Do not exceed recommended baking temperature.

Finely chopped or slivered nuts may be added.

WHOLE WHEAT SPICE CAKE 202B

2½ c. Whole Wheat Flour
3 tsp baking powder
½ tsp soda
½ tsp salt
1 tsp cinnamon
½ c powdered skim milk
⅔ c vegetable oil
1 c dark brown sugar
4 eggs
1 c buttermilk

Sift dry ingredients into bowl, make a well, add oil, eggs, buttermilk and stir until well mixed. Bake in long loaf pan at 350° F. about 45 minutes or until cake shrinks away from sides of pan.

FLUFFY FROSTING 202C

1 c dark brown sugar
1 egg white
¼ tsp cream of tartar
½ c boiling water
1 tsp vanilla (optional)

Mix sugar, egg white and cream of tartar together in bowl, add boiling water and beat vigorously until frosting stands in peaks. Spread on cooled cake.

SPICY BANANA SOY BARS 202D

Anne Mihaylo

3 tsp baking powder
1 c Whole Wheat Pastry Flour
1 c soya flour
1 c powdered skim milk
½ tsp salt
1 tsp cinnamon
½ tsp allspice
1 c chopped walnuts
½ tsp nutmeg
2 large eggs
½ c oil
1 c dark brown sugar (packed)
½ c buttermilk
1½ c mashed bananas

Sift all dry ingredients together, add brown sugar, nuts and mix well. Make a well and add oil, eggs, buttermilk and mashed bananas. Mix until well blended. Bake in long loaf pan at 350° F. for 45 minutes or until cake shrinks from sides of pan. Cut into bars while still warm and cool on wire rack. Set pan on rack as soon as it comes out of oven so bottom will not become soggy.

CAROB DATE NUT LOAF 203

Ethel B. Spear

½ c butter or margarine
1 c honey or brown sugar
½ c Carob Powder
1 tsp vanilla
½ tsp salt
4 eggs, separated
1 lb. coarsely chopped stoned dates
1 lb. whole walnut or pecan meats
1 c Whole Wheat Flour

Place dates and nuts in a bowl, cover with sifted flour and salt. Mix well. Cream honey, butter and Carob Powder and add vanilla and beaten egg yolks. Mix well. Add flour and mix well. If too dry, add 1 Tbs water and mix. Fold in the stiffly beaten egg whites.

Bake in square cake pan well oiled and lined with waxed paper. Bake at 350° F. for about 1 hour.

ORANGE DATE LOAF 203-1

1 large orange	1 tsp baking powder
1 c sliced dates	½ tsp soda
2 Tbs oil	½ tsp salt
1 c honey	1 tsp vanilla
1 egg (beaten)	½ c chopped walnuts
2 c Whole Wheat Flour	

Juice the orange into a one-cup measure. Fill cup with hot water, pour over dates and let cool. Grind orange rind. Cream oil and honey (or sugar). Blend in egg, then sifted dry ingredients alternately with date mixture. Stir in ground orange rind, also vanilla and nuts. Pour into greased loaf pan (about 5x9x4) and bake at 325° F. for 1 hour and 20 min., or until done.

ORANGE PECAN BREAD 203-2

2nd Prize 1965 Pomona Fair. Mrs. C. A. Henderson.

2¾ c Whole Wheat Flour	1 c honey (clover preferred)
2½ tsp baking powder	1 egg
½ tsp soda	2 Tbs grated orange peel
1 tsp salt	¾ c orange juice
2 Tbs butter or margarine	2 c broken pecan meats

Beat softened butter into honey until creamy; add unbeaten egg and orange peel and mix well. Add to dry ingredients alternately with orange juice, mixing well after each addition. Stir in nut meats and spoon into well-greased 5x9 inch loaf pan. Bake at 325° F. for 1 hour 10 minutes or until done.

Hint: When baking with honey use a moderately slow (325°) oven to prevent scorching.

RAISIN LOAF 203-3

1 c dark brown sugar	1 tsp cinnamon
⅓ c oil	½ tsp nutmeg
1 c raisins	¼ tsp allspice
1 c currants or 2 c raisins	½ tsp salt
½ tsp cloves	1 c water

Stir together. Cook 3 minutes. Cool.

Add:
2 c Pastry Whole Wheat Flour
1 tsp baking powder
¾ c coursely chopped walnuts

Bake 300° F. for 1 hour and 20 minutes in a paper-lined loaf pan.

SUNSHINE CAKE 204

(with Carob Powder)
(Courtesy of Living Foods Study Group of Pasadena)

4 large Eggs, separated	Grated rind of large lemon
1 c Brown Sugar	1¼ c Pastry Whole Wheat Flour, mixed with
⅓ c Water	¼ c CAROB POWDER sifted
3 tsp Baking Powder	
3 tsp Vanilla	

Have ingredients at room temperature. Sift baking powder with ½ c flour. Beat egg yolks until light and thick. Add sugar gradually and continue beating. Add flavoring and lemon rind. Add water and cup of mixed, sifted flours alternately; then the baking powder mixture; and lastly fold in the stiffly beaten whites of eggs. Place in one greased tube pan. Bake at 325° for 40 to 50 minutes. When done, invert pan. When cool, cut out. Frost with whipped cream if desired; or, with the following Carob Frosting.

CARA-COA CAKE 204-B

½ c soft butter or margarine	1 tsp soda
1⅓ c brown sugar	1 tsp salt
2 eggs	1 tps instant coffee
½ c Cara-Coa Carob Powder	⅔ c buttermilk
½ c water	1½ tsp vanilla
2½ c sifted El Molino Unbleached White Pastry Fl. or Pastry Whole Wheat Fl.	⅔ c chopped nuts or El Molino Hulled Sunflower seeds (optional)

Cream shortening and sugar well, add eggs, beating until fluffy. Blend Carob Powder with water. Stir into creamed mixture, blending well. Combine dry ingredients, sift together three times; add to creamed mixture alternately with buttermilk, beating after each addition. Add vanilla and nuts. Bake in two 8 inch oiled layer cake pans at 350° for 30 - 35 minutes.

CAROB FROSTING 205

Cream 2 Tbs butter with ⅔ c powdered milk. Add ⅓ c CAROB POWDER, mix well, then add ¼ c honey, 4 Tbs cream and 1 tsp vanilla. Beat until smooth and spread on cool cake.

CARA-COA FROSTING 205A

Melt . . . 1 c Cara-Coa Nuggets in bowl over hot water.
Add . . . 1 c sifted confectioners sugar and 3 Tbs evaporated milk
Beat . . . until smooth and glossy
Frosts . . . one 9 inch square cake or 18 cup cakes.

CARA-COA FUDGE FROSTING 205-B

Combine:

3 c brown sugar	1 Tbs. Cara-Coa Carob Powder
⅓ c rich milk	

Stir until sugar is thoroughly dissolved, then cook over medium flame to soft ball stage when tested in cold water, or 234° on a candy thermometer. Remove from heat. Add: 2 Tbs butter or margarine and 1 tsp vanilla. Allow to cool to lukewarm, beat until thick.

CARA-COA BUTTER CREAM ICING 205-C

Sift together:

3 c confectioner's sugar	⅓ c Cara-Coa Carob Powder
	¾ tsp instant coffee

Soften: ½ c butter or margarine, beat in one egg and 3 Tbs cream. Add sugar mixture, beating well. Spread between layers, top and sides of cake.

CAROB NUT BROWNIES 206

⅔ c El Molino pastry whole wheat flour	4 Tbsp El Molino Carob Powder mixed with:
1 tsp. baking powder	1 Tbsp melted butter
½ tsp. salt	1 c chopped nuts or El Molino Sunflower Seeds
½ c butter or margarine	3 Tbsp milk
⅔ c brown sugar or ⅓ c brown sugar and ⅓ c honey	1 tsp ground coriander seed (optional)
2 eggs	
1 tsp vanilla	

Method: Cream butter and sugar until well blended. Add eggs, salt, vanilla, coriander seed and Carob Powder containing melted butter; beat vigorously. Sift baking powder with the flour. Add flour, milk and chopped nuts to mixture. Spread in a 9" x 9" pan lined with waxed paper. Bake for 30 minutes at 350° F. Cut brownies before they have cooled.

CAROB POWDER adds flavor and appeal when added in various amounts to: HOT CAKES or WAFFLES, CAKES, COOKIES, ICE CREAM SHAKES, CANDIES, PUDDINGS, ICINGS, etc.

Use Your favorite recipes with CAROB POWDER in place of chocolate or cocoa.

GENERAL RULE: 3 level Tbs CAROB POWDER plus 2 Tbs liquid (milk or water) equals 1 square of chocolate.

CAROB FUDGE 207

2 c Brown Sugar	Sprinkling of hulled sunflower seed or hulled sesame seed, or nuts.
6 Tbs CAROB POWDER	(Flavor may be improved by lightly toasting sunflower seed
2 Tbs Butter or Margarine	
⅔ c Milk	
Pinch of Salt	

1½ tsp Vanilla or sesame seed.)

Combine CAROB POWDER with sugar, add milk, butter and salt. Boil to soft ball stage (225° to 230°). Add vanilla and seeds or nuts, beat until mixture is creamy. Pour into well buttered dish and cut in squares.

CAROB CANDY, UNCOOKED 207A

¾ c carob powder	1 tsp vanilla or peppermint flavoring
½ c heavy cream	2 Tbs soya powder
½ c honey	

Enough powdered milk to thicken. Add a cup or more of any kind of nuts, sunflower seeds, sesame seeds or coconut.

CARA-COA FUDGE SAUCE 207B

Combine:

1 c Cara-Coa Nuggets	Cook over low heat stirring
½ c honey and	until nuggets melt. Blend
½ c evaporated milk	well, cool.

FLAKY PIE CRUST 208

(Makes two 9 inch crusts)

2 c sifted Pastry Whole Wheat Flour	2 Tbs Wheat Germ
1 tsp salt	¾ c margarine
	4 to 5 Tbs ice water

Sift flour with salt into medium bowl, add Wheat Germ.

With pastry blender cut in shortening, until mixture resembles coarse cornmeal. Sprinkle ice water, 1 Tbs at a time, over pastry mixture, mixing lightly with a fork. Pastry should be just moist enough to hold together.

Divide pastry in half, shape into a ball. On lightly floured board or pastry cloth roll out half of pastry to an 11 inch circle. Fit into pie pan. Trim bottom crust even to edge of pan.

Roll out second half of pastry and place over filling. Seal edges, make a few gashes near center for steam vents.

For one crust pie, make one half of the recipe and roll out as above. Place in pie pan and bake at 450° F. for 8 to 10 minutes.

WHOLE WHEAT PIE CRUST 208A

(makes two 9 inch crusts)

2 c Pastry Whole Wheat Flour	½ c peanut oil
1½ tsp salt	¼ c cold whole milk

Lightly stir oil and milk into sifted flour and salt and roll out and bake as described above.

CAROB CREAM MINT PIE 209

1 large egg yolk	⅓ c Brown Sugar
¾ c milk	⅛ tsp salt
3 El Molino Cara-Coa Carob Candy Bars (7/8 oz. size)	1 c cream
1 Tbs unflavored gelatin	¼ tsp Oil of Peppermint
	1 9 inch baked pie shell

Slightly beat egg yolk with milk and add broken pieces of carob candy. Combine with gelatin, sugar and salt in top of double boiler over boiling water. Stir frequently until candy melts.

Remove from heat and beat until smooth. Chill until cream-like consistency. Fold in whipped cream flavored with oil of peppermint.

Turn into pie shell. Chill until firm.

For variation omit peppermint flavoring and add sliced bananas to pie shell before adding filling.

EL MOLINO MUFFIN MIX RAISIN COOKIES 210

(another prize winner—by La Ree McCauley)

½ c honey	⅓ c milk
4 Tbs oil	1 c chopped raisins
1 egg	1 c chopped dates
1½ c El Molino Muffin Mix	1 c chopped nuts

Cream oil and honey, add egg and beat well.

Combine Muffin Mix, nuts and fruits alternately with milk. Drop by spoonfuls on greased tin. Bake at 375° F. for 10 to 12 minutes. Yields about 3 dozen.

1 tsp cinnamon & ½ tsp nutmeg may be added if desired.

For delicious chocolate-like cookies, mix 3 Tbs Carob Powder with the Muffin Mix and add about 2 Tbs milk.

CAROB THINS 211

Agnes Follett

½ c oil	1 c Unbleached White Flour
1 Tbs milk	3 Tbs Carob Powder
1 Tbs honey	½ tsp salt
1 Tbs lemon juice	
1 c Whole Wheat Flour	

Place oil in bowl and add 3 Tbs boiling water and milk. Beat until it is thick and creamy, add honey and lemon juice, and beat well. Sift flour and measure, dip out three rounded tablespoons and replace with three rounded tablespoons of Carob powder. Sift again. Turn into mixture, mix well. Form into loaf, roll between two sheets wax paper. Be sure the paper is no longer than cookie sheet that you bake it on. Carefully slip wax paper from top. Prick with fork. Cut into 1½ inch squares. Slip paper and all on to cookie sheet. Bake 8 to 10 minutes starting at 400°, finish with 350°. (They burn easily)

CAROB COCONUT DROP COOKIES 211A

Mrs. Joy Sousa

1 c dark brown sugar	½ tsp vegetable salt
½ c soy oil	1 tsp cinnamon
¼ c milk	¼ tsp nutmeg
2 eggs	1 tsp vanilla
3 Tbs carob powder	½ tsp almond extract
2 tsp baking powder	1½ c rolled oats
1 c grated fine unsweetened coconut	1 c whole Wheat Pastry Flour

Cream oil and sugar, add beaten eggs and milk, gradually add dry ingredients which have been mixed together, add almond extract and vanilla, mix well and drop by teaspoon on oiled baking sheet. Bake at 350° F. for 10 to 12 minutes.

SESAME SEED COOKIES 212

Elizabeth Wolfe

1 c Hulled Sesame Seed	½ tsp salt
½ c cocoanut (shredded or macaroon)	¾ c oil
2 c Unbleached White Flour	1 c brown sugar
1 tsp baking powder	1 large egg
½ tsp soda	vanilla or almond extract to taste

Lightly toast sesame seed and cocoanut until light brown. Sift together: flour, baking powder, soda and salt. Cream oil with brown sugar, add egg, vanilla or almond flavor, toasted sesame seed and cocoanut. Beat well and blend in dry ingredients. Shape in balls (about 1 tsp in each ball). Place on cookie sheet, flatten with fork. Bake at 350° F. for 10 to 15 min.

WHEAT GERM DROP COOKIES 213

½ c oil	1 c brown sugar
¼ c milk	2 eggs, beaten
2¼ c Whole Wheat Flour	½ c wheat germ
2 tsp baking powder	2 tsp nutmeg

Add oil to the sugar gradually. Add the milk and beaten eggs, then stir in the dry ingredients and beat well. Drop by teaspoonfuls on a greased baking sheet. Bake at 350° F. for 5 minutes then at 325° for 7 minutes. Makes about 3 dozen cookies.

Variations: 213A

ALSO add a spoonful or more of Wheat Germ to each of the following for extra vitamins and flavor: Sandwiches, salads, meat loaf, puddings, jello, desserts, candies, stuffings, fruit juices, soups, sauces, pancakes, pies, waffles.

PEANUT BUTTER COOKIES 214

(using oats, wheat, soya)

Lillian Batchelor

1 c oil	1½ c Pastry Whole Wheat Flour
2 c brown sugar	1 tsp salt
½ c peanut butter	1½ tsp cinnamon
3 eggs	1 tsp mace
5 Tbs buttermilk	¼ tsp cloves
1 tsp soda	1½ c seedless raisins
1½ c Soya Flour	1½ c Rolled Oats

Lightly toast Rolled Oats in a warm oven.

Mix oil and sugar, add peanut butter and beaten eggs. Dissolve soda in buttermilk and add to mixture.

Mix Pastry Whole Wheat Flour and Soya Flour, salt, cinnamon, mace, cloves, raisins. Crush rolled oats between palms of hands and add. Combine first mixture with second mixture.

Drop with tsp on cookie sheet and bake at 375° for 15 to 18 minutes.

ICE BOX COOKIES — 215

½ c vegetable oil
1 c brown sugar
1 egg
2 Tbs cold water
1 tsp vanilla
pinch of salt
2 tsp baking powder
2 c Pastry Whole Wheat Flour
1 c Wheat Germ
Hulled Sesame Seed (for dipping)

Mix oil and sugar and let stand a few minutes. Add well beaten egg, water, vanilla, salt, sifted flour and baking powder. Stir in Wheat Germ. Shape into a roll. Wrap in wax paper and chill in refrigerator overnight. Slice thin and bake in hot oven until brown. Delicious when top side is dipped in sesame seed before baking.

SOFT MOLASSES COOKIES — 215A

Mrs. Mabel R. Carey

3½ c sifted pastry whole wheat flour
1 tsp baking powder
1 tsp soda
1 tsp salt
2 tsp cinnamon
1 tsp ginger
½ tsp cloves
¾ c oil
½ c brown sugar
½ c unsulphured molasses
¼ c honey
1 egg
¾ c buttermilk

Sift and mix together the flour, baking powder, soda, salt and spices. Mix the oil with the sugar, add egg and molasses and honey. Add flour mixture alternately with the buttermilk. Chopped raisins may be added if desired.

Drop from teaspoon on greased baking sheet. Bake at 350 to 400 deg. for 12 minutes or until done. Makes several dozen cookies.

MILLET PUDDING — 216

Mary Butz

2 c milk
¼ c honey
½ tsp vanilla
⅓ tsp lemon extract
¼ c Millet Meal
1 or 2 eggs
1 Tbs molasses

Vanilla Rice Custard (see #306A)

Heat 1½ c milk in double broiler with ¼ c honey. Mix ½ c cold milk with ¼ c millet meal. Add millet meal mixture to hot milk and let cook over boiling water for 25 min., stirring occasionally.

Beat 1 or 2 eggs and add hot pudding, beating well. Pour back into double boiler and let cook 5 min. more. Stir constantly. Add 1 Tbs. (unsulphured) molasses, ½ tsp vanilla and ¼ tsp lemon extract. Chill and serve with cream or fruit and cream. (serves 6)

WHOLE WHEAT JELLY ROLL — 217

6 egg yolks
¼ c oil
¾ c honey
¼ c skim milk (liquid)
1½ c Pastry Whole Wheat Flour
½ c powdered skim milk
1½ tsp baking powder
½ tsp salt

Beat egg yolks until thick and lemon colored. Add oil, honey and milk, blend well. Add sifted dry ingredients in two parts and mix well. Fold in stiffly beaten egg whites. Turn into wax paper lined jelly roll pan (large) and bake at 375° F. 20 to 25 minutes, until a golden brown. Turn out on a towel, remove wax paper and spread with jam or jelly or pudding and roll immediately.

WHOLE WHEAT APPLESAUCE CAKE — 218

1½ c Pastry Whole Wheat Flour
¾ c Soya flour
½ c powdered skim milk
4 tsp baking powder
1 tsp salt
2 tsp cinnamon
½ Wheat Germ
1 c dark brown sugar
½ c oil
4 eggs (beaten well)
1 can applesauce (medium size)
1 c raisins)

Sift all dry ingredients together, except the wheat germ and brown sugar, then add and mix well. Combine oil, eggs, applesauce and raisins to dry ingredients and mix thoroughly. Turn into a well greased loaf pan and bake 1 hour at 375° F.

BUTTERSCOTCH BROWNIES — 219

2 c dark brown sugar (packed loosely)
½ c oil
2 eggs, large
1 tsp vanilla
½ c Soya Grits (soak in ½ c hot water)
⅔ c Pastry Whole Wheat Flour
⅔ c Wheat Germ
½ c powdered skim milk
2 tsp baking powder
½ tsp salt
1 c walnut meats, chopped

Combine sugar, oil and eggs, mix well. Add sifted dry ingredients, wheat germ, soya grits and nuts. Bake in greased and floured pan at 375° F., 25 to 30 minutes. The brownies will be moist. Let cool in pan on rack for about 5 minutes before cutting into squares.

OATMEAL SESAME COOKIES — 220

½ c oil
1 c dark brown sugar
1 egg (well beaten)
1¼ c Rolled Oats
1¼ c Pastry Whole Wheat Flour
2 Tbs milk or buttermilk
½ tsp soda
¼ tsp salt
½ tsp nutmeg
1 tsp cinnamon
½ c raisins (chopped)
¾ c Sesame Seeds

Cream oil and sugar, add beaten egg, mix thoroughly. Combine milk, raisins, sesame seeds and rolled oats, add to previous mixture. Add sifted dry ingredients and mix well. Drop from teaspoon on to greased cookie sheet, flatten with fork dipped in cold water. Bake at 375° F. until browned. This cookie is crisp and keeps well.

CAROB TOLL HOUSE COOKIES — 221

2 c sifted El Molino Pastry Whole Wheat Flour
½ tsp Salt
½ tsp baking powder
½ c El Molino Wheat Germ
1½ c El Molino Rolled Oats
1 c Cara-Coa Nuggets
½ c El Molino Soya Grits, soaked*
2 eggs, beaten
1½ c dark brown sugar
1 c margarine or butter
2 tsp vanilla

Beat sugar, margarine or butter, vanilla with eggs. Add dry ingredients. Drop onto oiled cookie sheet and bake at 375°F., approximately 10-12 minutes.

* To soak Soya Grits: cover with boiling water for 5 minutes, drain. (Or, substitute Hulled Sunflower Seeds)

CARA-COA NUGGET COOKIES — 222

PREHEAT oven to 375° F.
CREAM:
½ c margarine or butter
½ c brown sugar and
1 tsp vanilla until light and fluffy.
FOLD IN:
1 beaten egg and mix well.
SIFT together:
1 c plus 3 Tbs El Molino pastry whole wheat flour
½ tsp soda and
½ tsp salt
ADD: sifted dry ingredients to creamed mixture; stir in
½ c chopped nuts and
⅔ c Cara-Coa Nuggets.
DROP by teaspoonfuls onto an ungreased baking sheet.
BAKE: 10-12 minutes.
YIELD: approximately 4 doz.

CAROB ICE CREAM — 250

Janna B. Blake

2 Qts milk (preferably raw)
6 eggs
2 Tbs Brown Rice Flour
2 c dark brown sugar
1 tsp salt
4 Tbs Cara-Coa Carob Powder (Variable)
2 tsp vanilla
1 pt. whipping cream

Heat milk in top of large double boiler. Combine, in blender, eggs, rice flour, sugar, salt and Carob Powder. Blend until smooth, then stir into heated milk in double boiler. Cook, stirring constantly, about five minutes or until mixture begins to thicken. Do no over-cook. Cool.

When ready to freeze, add vanilla and blend one minute. Add whipped cream to blended mixture. Freeze. (For smooth, creamy texture use ice cream freezer.)

If not using ice cream freezer, put in freezing tray for 20 minutes. Remove and stir vigorously with fork. Freeze another 20 minutes and repeat. Return to freezer for about 2 hours.

MRS. SMITH PAID:

$5.40 FOR (1953 prices) $5.40 FOR

4½ lbs. BEEF   25 lbs. SOYBEANS

(rib roast)

MRS. SMITH RECEIVED:

from beef		from soy beans
6	SERVINGS	150
13	DAYS PROTEIN	180
355	TOTAL PROTEIN (gm)	4,540
5,659	CALORIES	37,569
204	CALCIUM (mg)	25,765
3,841	PHOSPHORUS (mg)	66,511
53	IRON (mg)	908
0	VITAMIN A (I. U.)	15,890
2	VITAMIN B1 (mg)	121
3	VITAMIN B2 (mg)	35

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- High PROTEIN of good quality, containing all the essential AMINO ACIDS.
- Low STARCH (1½ %).
- In various forms, Soybeans contain practically all the known VITAMINS.
- Easily digestible OIL.
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The SOYBEAN is becoming appreciated in America and deserves to be used far more. Treat YOUR family to this ancient "new" vegetable.

COOKING El Molino "Cooks Best" SOYBEANS 301

Add 1 cup soybeans to 3 cups boiling water and soak overnight. Drain and rinse.

Add: Small ham hock or 1 Tbs oil.
1 small diced onion.
¼ cup diced celery.
2 bay leaves.
2 tsp salt

Add water to cover. Bring to a boil, lower heat and simmer for 2½ hours.

SOYBEAN CASSEROLE 301A

2 c cooked soybeans, chopped
¼ c diced salt pork
2 c chopped celery
2 Tbs chopped onions
2 Tbs chopped green pepper
6 Tbs flour
2 c milk
1 Tbs salt
1 c buttered bread crumbs

Brown the salt pork in a frying pan. Add the celery, onion and green pepper, and saute for about 5 minutes. Add thickening made from the flour, milk, and salt and stir until it reaches the boiling point. Stir in the cooked beans, and pour the mixture into a greased baking dish. Cover with the buttered bread crumbs. Bake in a moderate oven (350° F.) for 30 minutes or until the crumbs are brown.

SOYBEAN MEDLEY CASSEROLE 301AA

Cover 2 cups Soybeans with hot water and soak overnight. Drain, rinse and cover with water.

Add:
1 small diced onion
¼ c diced celery
2 bay leaves
1 tsp salt
1 Tbs oil

Bring to a boil in covered pan, lower heat and simmer for 2½ hours.

Chop coarsely:
1 large onion
4 large stocks celery
½ large green pepper

Simmer in covered pan in 2 Tbs oil or butter for 5 minutes. Add 1 cup canned or 2 large ripe tomatoes, cut up. Cook 5 minutes, add salt to taste and ½ tsp. savory. Combine with cooked soybeans, heat and serve.

SOYBEAN LOAF 301B

2 c cold cooked soybeans
1 c bread crumbs
1 egg
2 strips of bacon
salt and pepper
½ to ⅔ c tomato sauce

The soybeans, which have been soaked and cooked, should be chopped, combined with other ingredients, formed into a loaf, with bacon across top, and baked for 45 minutes. This recipe may be varied, using rice, potatoes, carrots, or chopped nuts. Two cups tomato sauce may be made in order to have sufficient quantity to serve with baked loaf.

SOYBEAN PASTE OR PULP 302

If soybeans are intended for use in loaves, patties or turkey, this procedure should be followed: Drain cooked beans through colander as they must be free from moisture. Put through a food press or sieve or mash thoroughly. This paste may be stored in refrigerator and used as needed. Other seasoning or coloring may be added when used. Use in making soups, croquettes, loaf or souffle. Cold, the pulp makes a nutritious and flavorful filling for sandwiches when mixed with chopped onion and enough salad dressing or milk to make it easy to spread. May be used like pumpkin or squash with milk, eggs, and spices as a filling for pie.

SOYBEAN SOUFFLE 302A

3 c soybean pulp
3 eggs
1 Tbs chopped onion
2 Tbs chopped parsley
Salt and pepper to taste

Beat the yolks of the eggs and add them to the other ingredients. Then fold this mixture into the well-beaten egg whites, and pour into a greased baking dish. Bake in a moderate oven (325° F.) for 30 minutes or until set. Serve immediately.

STUFFED TOMATOES 302B

8 or 9 large tomatoes
1 tsp salt
2 c soybean pulp
½ c diced celery (cooked in ¼ c water)
1 tsp minced onion
½ tsp minced green pepper
buttered whole wheat bread crumbs or wheat germ

Remove pulp from center of large tomatoes. Sprinkle inside with salt. Fill with mixture of pulp, celery, onion, and green pepper. Cover tops with buttered crumbs. Place in greased pan and bake in a hot oven (410° F.) for 25 to 30 minutes or until tomatoes are soft.

STUFFED PEPPERS 302C

8 or 9 green peppers
1 tsp salt
2 c soybean pulp
½ c diced celery (cooked in ¼ c water)
½ c or more tomatoes
1 tsp minced onion
whole wheat buttered bread crumb or Wheat Germ

Remove seeds and inner partitions from green peppers. Parboil peppers for 3 minutes in salted water. Sprinkle inside with salt. Fill with mixture of bean pulp, celery, tomatoes and onion. Cover tops with buttered crumbs. Place in greased pan and bake in a hot oven (410° F.) for 25 to 30 minutes or until the peppers are soft.

BAKED SOYBEAN CROQUETTES 302D

2	Tbs minced onion	2	Tbs melted fat
1½	c diced celery	3	c soybean pulp
1½	teaspoon salt		corn flakes
1	c tomato puree	1	egg, well beaten
5	Tbs flour	2	Tbs milk

Add minced onion, celery (tough celery should be par-boiled), and salt to tomato puree and bring to a boil. Mix flour and fat together, and add the boiling tomato puree mixture slowly. Cook to a thick paste. Cool and add soybean pulp. Shape into croquettes. Roll in corn flakes, then in beaten egg to which milk has been added, and again in corn flakes. Place on a greased baking sheet and bake in a hot oven (410° F.) for 20 to 30 minutes.

SOY CHILI CON CARNE 303

2	c cooked soybeans #301	½	lb. lean ground beef
¼	lb. diced salt pork	2	c tomatoes
¼	c chopped onions	1	Tbs chili powder

Fry diced salt pork until crisp. Remove the pork and add the onions. Cook until brown. Add ground beef. Stir well, cover and cook 10 min. Add the crisp pork, beans, tomatoes, and chili powder. Bring to boil and serve.

MEATLESS SOY CHILE CON CARNE 304

Follow above recipe, using 4 Tbs margarine or oil in place of salt pork, ½ c onions, and 1 medium can of meat substitute diced in place of lean beef. Add desired meatlike flavoring.

BAKED SOYBEANS 305

2 c cooked soybeans #301	2 c canned tomatoes
2 c canned corn	1 scant c buttered whole wheat bread crumbs or wheat germ
1 c grated cheese	
1 tsp salt	

Alternate layers of beans, corn, cheese and drained tomatoes into a greased baking dish. Mix salt with tomato juice and pour over the mixture. Cover with buttered crumbs and bake in a moderate oven for 30 minutes, or until crumbs are brown.

SALTED SOYBEANS 305B

Salty soys are prized for their rich, nutty flavor.

EXCELLENT FOR APPETIZERS

Because soybeans contain so much protein and fat, they are good fried in deep fat and salted to serve like salted nuts.

Wash and soak the dry beans overnight, then drain, and spread them out at room temperature until the surface is dry. Fry a few at a time in deep fat 350° F. for 8 to 10 minutes. Drain on absorbent paper and sprinkle with salt while still warm.

COOKING NATURAL BROWN RICE 306

1 c Brown Rice
1 tsp salt

Add rice and salt to 2 to 2½ c cold water and bring to a boil and boil for 3 minutes. Cover tightly, turn heat very low and simmer for 45 minutes without lifting lid. Turn off heat and let set on hot burner 10 minutes. The water should be absorbed and the rice can be separated by stirring with a fork. Serves four people. DO NOT remove lid until ready to serve.

VANILLA RICE CUSTARD 306A

3	Tbs cooked rice	3	Tbs brown sugar
1	c milk (skim or whole)	1	tsp vanilla
1	egg (beaten slightly)	½	c raisins (optional)

Nutmeg to sprinkle over top when ingredients are well mixed. Bake in 325 degree oven about 1 hour or until silver knife comes out clean after testing.

QUICK SPANISH RICE (Meatless) 306B

¼	c olive or peanut oil	½	Medium Green Pepper, diced
1	medium onion, thinly sliced		
1½	c cooked rice		
1	c hot water		pepper to taste
1	tsp salt	2	cans tomato sauce

Heat oil, add onion, green pepper and rice. Cook and stir over high heat until lightly browned. Add hot water, tomato sauce and seasonings, mix well, bring to a boil, cover and simmer 20 min., stir occasionally.

CHINESE RICE (With Left-Over Meat) 306C

1	c rice	1	c cooked, diced ham or pork
1½	c water		
1	tsp oil	2	eggs
1	c celery (chopped fine)	3	Tbs oil
1	onion		salt, pepper, soy sauce

Bring water to a boil, add 1 tsp oil, add rice, steam as usual. Heat 3 Tbs oil in skillet, stir in eggs, add rice, celery and onions, salt and pepper. Cook over high heat about 5 min. Stir frequently—add soy sauce.

STUFFED PEPPERS 306D

Brown ½ c chopped onion & 1 lb. ground beef in 2 Tbs. oil, add 1 c cooked rice, 1½ c sieved tomatoes, ¼ c of the tomato juice, salt & pepper to taste, simmer 10 to 15 min., stir often. Cut tops off of 6 green peppers, remove seeds, drop into boiling water for 1 min. Add mixture to peppers in baking dish, bread crumbs or cheese may be added to tops, if desired. ½ c water added to baking dish will keep peppers tender and moist while baking for about 30 min. in moderate oven.

RICE STUFFING (For Fowl) 306E

2	c cooked rice		dash of pepper
½	tsp salt	1	Tbs chopped parsley
2	Tbs chopped onion	¼	c diced celery
3	Tbs melted butter	½	tsp sage or thyme

Mix all ingredients together thoroughly. This amount makes enough for one small roasting chicken, or duck. For larger fowl, increase recipe. To vary, chopped nuts or apples may be added.

HERB RICE 306F

1	c brown rice	2	Tbs soy oil
1	clove garlic, minced	1	envelope G. Washington Broth (Brown)
⅛	tsp Spice Island Fine Herbs	1½	c boiling water

Brown rice, garlic and herbs in oil. Add boiling water and cook tightly covered, letting no steam escape for 40 minutes over lowest possible fire. Stir lightly to separate grains. Add generously of raw parsley and chives.

DROP DUMPLINGS 307

Using El Molino Muffin Mix

A favorite recipe of Hazel Parcells, Ph. D.

2	eggs	1½	c El Molino Muffin Mix
½	tsp salt		
2	Tbs vegetable oil		
½	c milk		

Beat eggs, salt, oil and milk together thoroughly. Add Muffin Mix. This should be stiff enough to drop from a spoon. As eggs vary in size, a little more Muffin Mix may be added if needed. Drop into boiling stock, cover tightly and keep boiling for 15 minutes. This serves six.

Delightful changes may be effected by the use of herbs such as: Marjoram, Rosemary, Parsley, Saffron, Sage or Thyme. Use only small amounts as too much spoils the effect.

TAMALE PIE — A LA MEXICAN STYLE 308

1	c corn meal	1½	c tomatoes
1	tsp salt	¾	lb. chopped beef
⅛	tsp pepper	½	tsp chili powder
1	chopped onion	½	tsp A-1 sauce
½	clove minced garlic	9	ripe olives

Mix cornmeal to a paste with 1 c cold water. Add ½ tsp of the salt to 2½ c boiling water and stir in cornmeal paste. Slowly cook 1 hour. Brown onion in fat, add garlic and meat and brown. Season, add tomatoes, cover and simmer gently

for one hour or until meat is tender. Grease a flat pan and add part of the mush. Pour in the meat mixture, add the olives and either cover with the remaining mush or add the mush in large spoonfuls to meat mixture. Bake at 350° F. for 30 minutes.

Variation:

Replace ½ c Corn Meal with Millet Meal

VARNISHKES 309

1 c Buckwheat Groats
1 Egg
¼ c Griven (that part of fat remaining after liquid has been rendered)
or
1 Tbs Oil
½ tsp Salt
Pepper to taste

Mix Buckwheat Groats with the beaten egg. Cook over low heat, stirring occasionally. Add 2 c boiling water and cook slowly for 15 to 20 minutes. Add the griven or oil, salt and pepper and cook 10 minutes more. Make a batter of ¾ c Unbleached White Flour, Two Eggs, a Little Salt, and 2 Tbs. Water. Knead the dough and roll thin. Cut into 2 or 2½ inch rounds. Place a small amount of buckwheat mixture on each round, fold over and seal edges with a fork. Place on baking pan and bake 20 minutes at 350° - 375° F.

BUCKWHEAT BLINTZES 310

1½ c Buckwheat Groats
3 eggs
¾ c whole wheat flour or Unbleached White
2 large onions
1 Tbs chicken fat
½ tsp salt

Mix the buckwheat with an egg. Place on fire until browned. Boil small quantity water and pour on buckwheat slowly until the buckwheat is completely covered. Add salt and allow to cook in double boiler at least 10 minutes. Knead a dough of the flour, 1 egg, a little fat and 2 Tbs water. Roll the dough very thin. Fry the onions and spread over the dough. Put the buckwheat over the onions and spread pieces of a hard boiled egg over the buckweat, together with a little chicken fat. Roll together, cut in 8 pieces, and place in hot oven for 30 minutes.

BUCKWHEAT KNISHES 311

(for 6 people)

1½ c Buckwheat Groats
4 eggs
3 c Whole Wheat Flour or Unbleached White
2 Tbs butter
½ lb. potatoes
3 onions
2 tsp salt
6 c water

STUFFING: Mix the buckwheat with 1 egg and place into the oven for 10 to 15 minutes. Boil water in another pot. When the buckwheat is browned, add the water, 1 tsp salt, 1 Tbs butter and allow to boil 30 minutes on slow fire. Fry the onions while the buckwheat is cooking.

DOUGH: Mash the boiled potatoes, add 3 eggs, 1 tsp salt. Add the flour and knead a thin dough. Mix the fried onions with the buckwheat, cut the dough into equal parts, add the buckwheat and roll knishes. Spread butter on pan and put in oven for 35 minutes.

BUCKWHEAT STUFFING 312

(dressing)

3 Tbs fat
1 chopped leek or sweet onion
1 diced stalk celery and leaves
1 or 2 diced pimentos
½ c mushrooms (optional)
2 Tbs parsley
2 C Buckwheat Groats (cooked) #313

Saute in fat all ingredients (except buckwheat) for 5 minutes. Stir in cooked Buckwheat Groats.

COOKING BUCKWHEAT GROATS 313

1 c Buckwheat Groats (whole)
2 c soup stock or water
1 tsp salt

Add unwashed buckwheat to liquid and add salt. Boil 1 minute, cover utensil, lower heat, and simmer 12 to 15 minutes.

BUCKWHEAT GROATS 314

(served with soup, or with gravy in place of potatoes.)

1 c Buckwheat Groats
1 egg
salt to taste
Fat or butter

Stir into skillet the Buckwheat and slightly beaten egg. Stir constantly over hot fire. When each grain is separate and dry, put mixture into a pot which has been put directly over the flame for a few seconds. Add 2 c of ACTIVELY boiling water, salt and cover tightly and allow to steam over low flame for 30 minutes. While cooking, stir in a little chicken fat. Serve hot with gravy or with soup.

CORNBREAD STUFFING 315

Day old Corn bread #115
4 c (or more) toasted whole wheat bread
2 onions (egg size)
1 clove garlic
1 tsp salt
¼ tsp pepper
¼ tsp poultry seasoning
sage to taste
3 eggs
2 Tbs butter or margarine

This is a basic recipe. The amount will depend on weight of bird. Bake cornbread the day before.

Crumble toasted whole wheat bread into a large bowl. Pour boiling water over bread, but not enough to make soggy. Cover bowl with a cloth to steam.

Dice and fry onions, garlic in bacon drippings until light brown and spread over bread in bowl.

Combine remaining ingredients using plenty of cornbread broken gently into small pieces. Stuff the bird—and let the drumsticks fly . . .

GOULASH 316

(using left-over cooked cereals, sprouts or by starting from scratch)
Lillian Batchelor

1½ lbs. stewing beef, chunks
3 Tbs oil
2 large onions, chopped
1 green pepper, chopped
1 carrot, chopped
1 c celery, diced
1 large can tomatoes
4 c Red Cereal Wheat (or other cooked grain)
salt to taste
chili powder (optional)

(If no cooked wheat or other cooked grains, whole or ground are on hand—soak grain overnight or in boiling water until softened.)

Brown meat and onions in oil, add all remaining ingredients and bake about 3 to 4 hours at 250° to 300° F. When using cooked grains, the baking time may be shortened by about one half.

MEAT LOAF 317

1½ lbs. ground beef
½ lb. ground cured ham
2 c cooked Red Cereal Wheat
1 onion, chopped and browned if desired
2 eggs

Mix in the order given. Form into a loaf and bake slowly 1½ hours. If cooked meat is used, bake ½ hour.

MEAT LOAF SUPREME 317B

1½ lbs. ground beef
1 c Wheat Germ
½ c minced onion
1 egg (slightly beaten)
½ c milk
1 small can tomato sauce
1 tsp salt
dash of worcestershire sauce
pepper to taste
½ tsp sage

Mix all ingredients thoroughly. Bake in loaf pan 1 hour, or until done, in 350 degrees oven.

POTATO FLOUR HAMBURGER STEAK 318

To make it tasty, loose and juicy, mix 2 Tbs of Potato Flour with some shredded onions into one pound of chopped or

ground meat.

Soaked Soya Grits or Soya Meal are also excellent additions to hamburger. Try dipping in Wheat Germ after moulding into patties; it's delicious.

LENTIL LOAF 319

(without meat)

2 c cooked lentils*	1 tsp salt
½ c wheat germ	3 Tbs oil
½ c bread crumbs	3 Tbs brewers yeast flakes
½ c chopped walnut meats	1 c evaporated milk
	1 egg
¼ tsp sage	1 small onion

*Drop lentils into boiling water. Cook over low heat for about 1 hour.

Slightly mash lentils. Add all dry ingredients. Beat the egg, add oil and milk. Add to lentil mixture. Shape and bake in a flat pan at 350° F. for 45 minutes. Cut in squares, arrange on platter. Cover with hot tomato sauce.

SAVORY GARBANZOS 320

Ethel B. Spear

(Makes enough to freeze left-overs for future use)

3 c garbanzos (rinse, cover with water, soak overnight) (see SHORT CUT FOR SOAKING #301)

2 Tbs oil	2 c canned tomatoes
½ c small onion rings	pinch of sweet basil
¼ c green pepper slivers	salt to taste

Salt garbanzos and cook for one hour in water used for soaking.

Simmer the onion rings and pepper slivers in oil about 3 minutes. Add tomatoes, basil and salt. Simmer a few minutes to blend flavors then add to cooked garbanzos which have been rinsed and drained. Bake for 1 hour at 350° F.

MILLET CASSEROLE 321

Saute 1 onion and 3 stalks celery. Brown 1 lb. ground beef and add dash of garlic salt. Add 1 cup Hulled Millet (may be browned). Place in baking casserole dish and mix in the following: 1 can mushroom soup; 2 cans water; 1 can mushrooms; ½ tsp. poultry seasoning; 1 tsp salt; ¼ tsp. pepper; 1 tsp. monosodium-glutamate (optional); ½ cup Hulled Sunflower Seed. Bake 1 hr. at 300° F.

Alkaline-forming: easily digestible. Naturally high in Vitamin G, Potassium, Lecithin, Silicon, Iron, Magnesium, Calcium, Phosphorous & essential Amino Acids.

COOKING CEREALS 400

Unground Grains:	1 c grain
Red Cereal Wheat*	1 tsp salt
Oat Groats*	2 c cold water (or more)
Brown Rice	
Buckwheat Groats	
Hulled Barley	
Rye	
*see #403	

Place grain, salt, water in casserole (no lid) over direct heat and bring to a boil. Place casserole on a raised shelf or trivet in an 8-quart pot, deep well cooker or steamer. Water in steamer should be boiling when hot casserole is placed inside. Water level in steamer should be 1 inch below casserole. Steam 30 minutes. Reduce heat to low and continue overnight (9 to 10 hours).

Hulled Millet see #406

Use 3 c water, 1 c milk, salt and 1 Tbs honey. Follow above directions, steaming for 1 hour only.

Flaxseed

Replace part of grain with flaxseed for laxative effects.

COOKING CEREALS (Continued) 401

Ground Grains:	Wheat Germ & Middlings
Cracked Wheat*	Soya Grits
Wheat Grits	Rye Grits
Seven Grain Cereal*	Barley Grits
Steel Cut Oats*	
Rolled Oats	
Corn Meal	
Hominy Grits	1 c grain
Millet Meal	1 tsp salt
*see #404	2 to 3 c cold water

Steam as described above until done, using 2 c water; or, cook in double boiler; or cook in saucepan over direct heat stirring frequently until boiling. Cook 5 minutes. Cover with tight lid and turn off heat. Let stand, without removing lid, for 20 minutes. Wheat germ or rice polish may be added to cooked cereal just before serving. Raisins, dates or other dried fruits added, just before covering with lid, provide natural sugars.

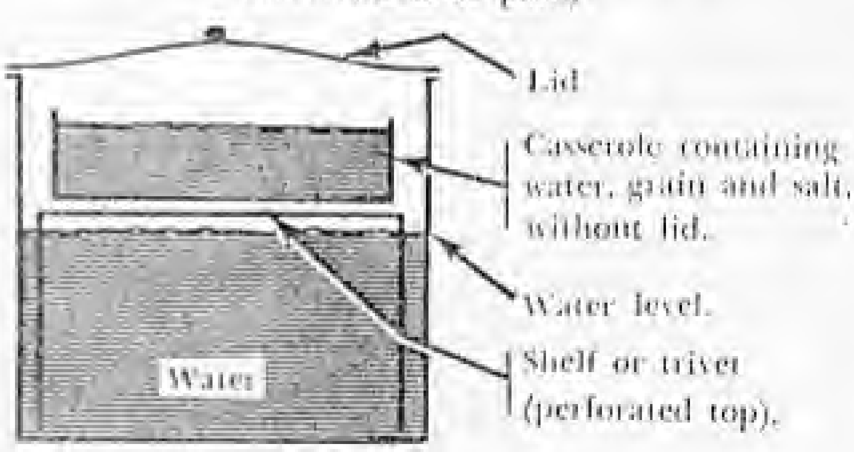
CANNING WHEAT 402

Place ¾ c Red Cereal Wheat in a pint jar. Add ⅓ tsp salt and fill the jar with boiling water to within 1 inch of the top. Adjust the lid, place in pressure cooker and process 1 hour at 10 pounds pressure.

If you want a QUICK, NOURISHING BREAKFAST this is it. Once a week while preparing dinner, put on the steamer and cook enough grain for the week. Store unused portion in jars in refrigerator. Re-heat a little as needed for cereal or add to other dishes. For variations at breakfast, keep jars of several different steamed grains ready to reheat.

HOW TO IMPROVISE A STEAMER

(Using a deep well cooker in stove or a combination of pans)



A steamer enables the steam vapor to come in direct contact with the grain which results in thoroughly cooked fluffy, separate grains.

QUICK WHEAT FOR "EAT 'N RUN" 403

(using a 1 quart thermos bottle)

1 c Red Cereal Wheat   1 tsp salt

While doing up the breakfast dishes . . . put a cup of wheat on to soak—just cover with water.

While doing up the supper dishes . . . drain off water into a measure adding enough more water to make 3 c. Heat to boiling. Add salt and soaked grain and bring to an active boil.

Pour boiling wheat and water into a pre-heated thermos. Tightly cap, turn on its side until time for breakfast. See hint on emptying #404.

Refrigerate leftovers in covered jars to re-heat as needed. Try using in #316.

A pint thermos may be used for smaller portions if desired.

Variation:

Replace half the wheat with Oat Groats. For a REAL TREAT add a Tbs or two Hulled Sunflower Seed to this mixture of wheat and oats.

QUICK CRACKED WHEAT 404

(using a 1 pint thermos bottle)

Here is a SIMPLE method of preparing a QUICK, NOURISHING breakfast from most any of the cereals listed in #401.

Just fix each morning after emptying the thermos prepared yesterday; or, prepare it the night before.

½ c Cracked Wheat
½ tsp salt

Pour grain and salt into a pint thermos bottle and fill with actively boiling water. Tightly cap, turn on its side to remain overnight.

Some grains absorb more water than others. Vary the accurately measured amount to suit individual preference.

Hint: Steel Cut Oats combined with the wheat in equal portions particularly compliment the wheat flavor. FOR A TREAT add a Tbs or two of Hulled Sunflower Seed to this mixture of wheat and oats.

Hint on emptying thermos: Empty thermos with a fork into cereal bowls. Pour milk into thermos and shake all the wheat free from sides and bottom. Pour this milk with wheat over each serving. Sweeten and enjoy.

CORNMEAL MUSH 405

(made with milk)

1 c Corn Meal (yellow or white) — 1 tsp salt — 4 c milk, whole or skimmed

Stir meal into ½ c cold water. Heat milk to boiling, add the salt and moistened meal. Mix well. When thickened, place in top of double boiler or over very low even heat and cook for about 30 to 45 minutes depending on the flavor desired. Serve hot with butter or milk or pour into loaf pan to cool.

When cold and firm, slice, coat with cornmeal or wheat germ or potato flour. Brown in fat and serve hot with honey.

MILLET CEREAL 406

½ c Hulled Millet — 1 Tbs Honey
1 c Water — ½ tsp Salt
1 c Milk — Raisins optional

Bring water, milk to boil in top part of double boiler (direct heat). Add Millet. Boil 5 minutes then steam over boiling water for 30 minutes. Add honey (raisins, dried fruit) and steam 5 minutes longer. 4 to 6 servings. For a quick breakfast—prepare in double boiler the night before.

GENERAL RULE

Use your favorite recipes with CAROB POWDER in place of chocolate or cocoa.

General Rule: 3 level Tbs CAROB POWDER plus 2 Tbs liquid (milk or water) equals 1 square of chocolate.

CAROB "PICK UP" 500

KAY BETTS in the Los Angeles Times advises: "For an afternoon pickup, try this in your blender:

Dissolve 2 tsp CAROB POWDER in ¼ c of boiling water. Add:

1 c milk — 1 sliced banana
1 egg — 2 or 3 pitted dates — ½ tsp vanilla

Blend thoroughly, pour into a tall glass and top with grated nutmeg."

CAROB SYRUP 501A

Keep a jar in refrigerator to add to hot or cold milk drinks (2 to 3 tsp. per 8 oz. glass)

¼ c carob powder — ⅔ c milk
⅓ c dark brown sugar — ½ tsp vanilla
pinch of salt

Mix sugar and carob powder, add milk and salt. Bring to a boil and simmer 5 minutes, stirring frequently. Add flavoring. Store in jar in refrigerator. For use as syrup for sundaes, add 2 tsp butter while simmering.

HOT OR COLD CAROB MILK 501B

(Made in liquefier)

3 Tbs Carob Powder — 4 c milk
1 Tbs powdered skim milk (optional) — ½ tsp smooth peanut butter
1 to 2 Tbs brown sugar (or honey or molasses to taste) — ½ ripe banana

Combine dry ingredients with 1 c milk. Place in liquefier and mix thoroughly. Add remaining milk, peanut butter and banana. Serve hot or cold. For egg-nog add 1 well beaten egg.

In preparing Carob Powder drinks, best results are obtained when using a liquefier; or a hand beater may be used to completely whip the dry ingredients into the liquid.

For EGG-NOG add 1 well beaten egg.

A Nitecap of CAROB MILK is just the thing to purrrr yourself to sleep.

CARA-MOCHA DRINK 501C

Blend . . . 3 Tbs fudge sauce (see recipe #207B) and ½ tsp instant coffee.

Add . . . 1 c milk, hot or cold. Stir to blend.

BRAN BROTH 502

(Use also for bread liquid)

1 c Bran (from red wheat)
2 c cold water

Soak bran in water overnight, the next morning pour into strainer and drain. Pour 1 c hot water through the bran stirring thoroughly, rinsing as much as possible. Reputedly a good blood tonic.

FLAXSEED TEA 503

8 c water — 8 Tbs Flaxseed

Place Flaxseed and water over low flame and simmer slowly for 15 to 20 minutes. Cool. Dip seeds out. Store in refrigerator.

Take 1 to 3 glasses each day as needed. It should be so thick you have to bite each mouthful rather than drink it. Lemon juice can be added to taste. It should be at room temperature, rather than ice cold, before consuming.

MILK FROM SOYA POWDER 504

1 c Soya Powder — 4 c Water

Mix water and powder gradually so that it is not lumpy. Let stand 2 hours, then cook in double boiler for 20 minutes. Strain through sieve or cheese cloth. Flavor with a small amount of honey and salt.

ALFALFA TEA 505

1 c Alfalfa Seed — 2 qts. Cold Water

Bring seed and water to boil. Cool, strain, store in glass jar in refrigerator. Use ¼ to ½ glass of this extract, fill glass with water, serve either hot or cold, with or without honey. Add mint leaves for delightful change.

RICE POLISH COCKTAIL 506

Loraine Langlois

1 c milk (whole or skim)
2 Tbs Rice Polish (heaping)
1 Tbs Brown Sugar (heaping) or desired sweetening.
4 or 5 drops vanilla

For greater calcium and flavor include:
1 Tbs powdered skim milk
1 tsp Carob Powder

Pour one half the milk into a blender (liquefier). Add all remaining ingredients. Mix thoroughly, add remaining one half c milk and mix a few seconds longer.

SOYA-PINEAPPLE TONIC 507

(Reputedly aids digestion and elimination)

Vigorously stir 2 heaping Tbs soya powder in 1 medium glass pineapple juice. Serve chilled.

SESAME COCKTAIL, BUTTER, DRESSING & SPREADS 508

Sesame Meal is used as a spread when mixed with honey or butter, or, spread mixture on yams a few minutes before serving; add Sesame Meal to a mixed vegetable salad as a dressing — no other oils are needed; mix Sesame Meal with water or juice in a liquefier for delicious sesame milk cocktail.

Make Your Own Authentic "TAHINI"
(SESAME BUTTER)

1 Cup Sesame Meal
¼ Cup Oil (any oil except sesame oil)
3 tsp Granular Lecithin

Place sesame meal in blender. Add ¼ cup oil at a time, blending well after each addition. Blend until the consistency of thin peanut butter. (The addition of lecithin aids emulsification.)

WET GLUTEN BASE 600

Ethel B. Spear

Gluten is very rich in protein and can be used to make delicious entrees. Gluten can be made from hard wheat flours (Whole Wheat Flour or Unbleached White Flour) or from Gluten Flour.

Mix 8 c flour with 2½ to 3 c lukewarm water to make a stiff dough. Form into a ball and knead well. Let stand under water for 2 hours. Wash out starch by kneading with the hands in the water, ever being careful to keep the dough together and pouring off only the starchy water. Continue adding more water, kneading and pouring off starchy water, until water is almost clear. You will then have a lump of wet gluten in its raw state.

COOKED GLUTEN 601

Ethel B. Spear

Put ½ c oil in 6 quart kettle with tight lid. Add 1 large chopped onion. When slightly browned, add one Tbs Savorex. Roll gluten into loaf, cut in slices and put in kettle and cover with boiling water. Boil 1 hour and drain. This is the basis for recipes calling for cooked gluten.

GLUTEN GRAVY 602

Use the liquid from cooking gluten steaks or vegetable water and thicken with whole wheat flour and add mushrooms.

EGG SAUCE 603

Ethel B. Spear

Heat vegetable oil (do not overheat). Stir in 1 egg and continue stirring until egg becomes fine, golden brown bits. Sprinkle in a little whole wheat flour, stirring lightly, then add just enough milk for desired consistency. Optional seasonings; salt, sodium glutamate, mushrooms, etc.

GLUTEN CUTLETS AND STEAKS 604

Use Cooked Gluten #601

1 Dip in egg, roll in potato flour, brown slowly in oiled pan.
2. Roll in Brewers yeast and flour, brown slowly in oiled pan.
3. Brush well with Savorex, dip in egg, then Potato Flour, brown slowly in oiled pan.
4. Brush well with Savorex, dip in egg, then Brown Rice Flour, brown slowly in oiled pan.
5. Brush well with Savorex, dip in egg, then Wheat Germ, brown slowly in oiled pan.

After any of the above breadings:

1. Place in oiled pan, cover with onion rings and bake in 350° oven until done.
2. Cover with can tomato soup or puree, or tomatoes, season and bake in 350° oven until done. Make sauce from juice.

GLUTEN BURGERS 605

Use Cooked Gluten #601

Run gluten through a meat grinder and place in mixing bowl. Season with G. Washington's broth or other seasoning. Stir in egg & grated onion. Mix in enough Potato Flour to make patties. Fry in skillet, browning each side. Cover and slowly steam for 5 minutes to bring out flavor.

GLUTEN CHOW MEIN 606

Ethel B. Spear

2	c coarsely chopped onions	2	c cut mushrooms.
4	Tbs vegetable oil	¾	c water
2	tsp Savorex (or Vegex or Savita)	1	tsp celery salt
1	c cooked gluten #601 (cut in thin strips 1½ inches long)	1	c bean sprouts
1½	c diced celery	3	Tbs soy sauce
			salt to taste
			arrow-root starch to thicken.

Add onions to hot fat. Stir well. Add Savorex then gluten and stir. Add celery, mushrooms and water. Cover and allow to cook five minutes stirring frequently. Add bean sprouts and remaining seasonings. Thicken with starch dissolved in cold water to creamy consistency. Serve hot on un-salted flaky, dry cooked brown rice.

GLUTEN PATTIES 607

Ethel B. Spear

Part 1		Part 2	
2	eggs (beaten)	2	c ground cooked gluten #601
1	onion, medium (finely chopped)	2	c cooked brown rice
¼	c soy sauce		
	dash of garlic salt		
½	tsp sage		

Mix Part 1 together then add Part 2. Mix thoroughly. Form into patties. Bake at 350° F. for 30 minutes; or, fry in oil slowly until nicely browned. Nice with tomato sauce.

GLUTEN COTTAGE LOAF 608

Ethel B. Spear

¾	c ground cooked gluten #601 or left-over steaks	1½	c hot mashed potato #108A
1	tsp sage	2	Tbs parsley
1	small onion chopped		

Make wheat germ or whole wheat crust as for a pie, (see #208, 208A), roll out as square as possible. Spread crust with potato, add rest of ingredients. Roll as you would a jelly roll. Cut in thick roll and bake in oven 425° F. Serve with gravy.

GLUTEN ROAST 609

Ethel B. Spear

Use all of the wet gluten from 8 c flour as described for GLUTEN BASE #600.

1	c English walnuts	2	Tbs Savita, dissolved in warm water
	bay leaves		
2	eggs	2	onions
½	c oil		salt

Put wet gluten through a meat grinder with the nuts and onions. Mix salt, eggs and oil with this and shape and put in a greased baking pan. Lay bay leaves over the top and add the Savita. Let bake until a good brown. As it is baking add a mixture of half water and half oil to keep it moist. Bake

about 1½ hours at 350° F.

GLUTEN VEGETABLE STEW 610

Ethel B. Spear

1 c diced carrots	4 Tbs Whole Wheat Flour
1 small onion	3 c raw potatoes (cubed)
1 c diced cooked gluten #601	2 tsp salt
2 Tbs oil	parsley (optional)

Add carrots and onion to 4½ c water and cook ten minutes. Brown gluten in oil and remove from pan. Brown flour in oil and make gravy from vegetable broth just made, and add to vegetables with potatoes and salt. Cook 15 minutes. Add gluten and cook until done. Garnish with parsley.

EGG FOO YOUNG 611

Ethel B. Spear

6 large eggs	2 small onions chopped
½ tsp salt	2 c brown rice
2 c bean sprouts (drained)	2 Tbs soy sauce
1 c chopped steak or cooked gluten #601	parsley and mushrooms (optional)

Beat eggs foamy and add rest of ingredients except rice and soy sauce. Blend lightly. Heat a small amount of oil or butter in a large heavy skillet and pour portions into pan (same as hotcakes). When set and brown on the bottom, turn and brown well on other side. Serve with hot steamed rice and any brown gravy to which has been added soy sauce. Garnish with parsley and mushrooms.

GLUTEN SOUR CREAM NOODLES 612

Ethel B. Spear

1 c ground cooked Gluten #601	1 can mushroom soup
1 8 oz. pkg. noodles	1 small onion chopped
1 8 oz. carton sour cream	salt to taste

Slightly brown chopped onion in small amount of oil or butter. Add gluten, sour cream and mushroom soup and mix well. Cook noodles in salted water, drain and combine with first mixture. Bake in oiled casserole for 30 to 40 minutes at 350° F., Serves 8.

GLUTEN BREAD 613

Hi-Protein — Lo Starch — 2 Loaves in 1½ Hours

2 Tbs. El Molino Active Dry Yeast	1 c El Molino Soya Flour
3½ c El Molino Gluten Flour	½ c El Molino Wheat Germ
	½ tsp salt (optional)

Measure 2 cups warm water (110°-115°F.) into bowl. Add yeast and stir until dissolved. Add blended dry ingredients. Beat until smooth.

Turn dough onto floured board and knead thoroughly until dough is smooth and elastic (about 15 min.). Shape into 2 loaves. Place in oiled loaf pans: 8½" x 4½" x 2½". (For higher loaf, use smaller pans.) Cover with towel. Let rise until dough raises towel. Bake in pre-heated 375° oven 45 min. Remove from pan and cool on rack.

One 23 gram slice provides: 30 Calories; Protein 5.09 gm.; Carbohydrates 4.3 gm.

GLUTEN SESAME THINS 614

Delicious with soup, salads . . . and for 'tween meal snacks and appetizers.

1 c El Molino Gluten Flour	½ tsp salt
¼ c El Molino Soya Flour	El Molino Hulled Sesame Seeds
¼ c El Molino Wheat Germ	
3 Tbs oil	

Mix well with 6 Tbs water. Form into firm ball and roll very thin on floured board. Sprinkle generously with sesame seed. Roll seed into dough well. Score dough in a diagonal pattern (for diamond shaped crackers) with a knife or pastry wheel. Lift to baking sheet. Bake at 425° for 10-12 minutes or until brown. Separate crackers after baking.

Hot Cakes and Waffles

BUCKWHEAT

CORNMEAL

SCRAPPLE

OLD FASHION' BUCKWHEAT HOT CAKES 700

2 c Pure Buckwheat Flour	1 c milk
1 Tbs active dry yeast	1½ tsp salt
2 Tbs brown sugar	
1 c Unbleached White Flour	

Dissolve yeast and sugar in 2 c lukewarm water. Sift and add both flours. Gradually add (scalded and cooled) milk and salt. Beat until smooth, cover and set in warm place, free from draft. Let rise 1 hour. When light, stir well and bake on a hot griddle.

To set overnight: Use only ¼ cake of yeast and add an extra ½ tsp salt. Cover and keep in cool place.

Variation:

Replace ½ c white flour with corn meal.

CORN CAKES WITH BUTTERMILK 700A

Mrs. Grant Groat

½ c wheat germ	½ tsp baking powder
1 c corn flour	1½ c buttermilk
½ tsp salt	2 Tbs vegetable oil
2 Tbs honey	1 egg
½ tsp soda	

Combine wheat germ, corn flour, salt, soda and baking powder. Stir in buttermilk, honey, oil and slightly beaten egg. Stir only enough to blend. Bake on medium griddle lightly oiled.

QUICK BUCKWHEAT HOT CAKES 701

1 c Pure Buckwheat Flour	¾ tsp salt
1 c milk	2½ tsp baking powder

Combine and bake on hot griddle.

WAFFLES 702

2 c Pastry Whole Wheat Flour	1 Tbs brown sugar
3 tsp baking powder	3 eggs
1 tsp salt	1¼ c milk
	½ c oil

Sift flour and measure. Resift with salt, sugar and baking powder. Mix the milk, and oil with well beaten egg yolks; and combine with dry ingredients and mix until smooth. Fold in stiffly beaten egg whites. Bake on hot waffle iron.

For a delightful change: replace about ¼ c flour with Carob Powder. Or, sprinkle Hulled Sesame Seed or Hulled Sunflower Seed on batter on iron just before closing to bake.

EL MOLINO'S PRIDE . . . HOTCAKES AND WAFFLES
using El Molino Muffin Mix
see #121

CORN MEAL WAFFLES 703

- ¾ c corn meal (yellow or white)
- ¾ tsp salt
- 2 tsp baking powder
- 2 eggs, separated
- 1¼ c milk (about)
- 2 Tbs brown sugar
- 5 Tbs oil
- ¾ c Whole Wheat Flour or Pastry Whole Wheat Flour

Sift dry ingredients together twice. Combine beaten egg yolks, milk and oil and stir in dry ingredients until just blended. Fold in stiffly-beaten egg whites. Bake on hot iron.

Delicious when served with apple sauce and cream, instead of syrup.

BROWN RICE FLOUR WAFFLES 704

- 2 c Brown Rice Flour
- 2½ tsp baking powder
- 1 Tbs brown sugar
- ½ tsp salt
- pinch of soda
- ¾ c milk
- ½ c sour cream
- 2 eggs
- 6 Tbs melted butter or oil

Combine beaten egg yolks, sour cream, melted butter, then the milk. Add slowly the mixed dry ingredients. Fold in stiffly-beaten egg whites. Bake on hot iron. Makes about 6 medium size waffles.

(sour cream may be replaced with milk)

CORN MEAL MUSH WITH PORK 705

An easily prepared scrapple)

- 1 lb. lean pork (including bone)
- 1 c Corn Meal
- 1 tsp salt
- ⅓ tsp powdered sage

Cook the pork in water until the meat can be removed easily from the bone. Remove the meat, cool the broth, and remove the fat. Reduce the broth to about a quart, or add water enough to bring it up to this amount, and cook the corn meal in it. Add the meat finely chopped and the seasonings. Pack in bread tins. Cut into slices and fry. Beef may be used in the same way. This serves 6 persons.

ORANGE WHOLE WHEAT HOT CAKES 706

- 2 c sifted stone ground whole wheat flour
- ½ tsp soda
- ½ tsp salt
- 2 eggs
- ¼ c soy oil

Enough fresh orange juice to make hot cake batter. Mix eggs and oil and beat. Add dry ingredients alternately with orange juice. Bake on lightly oiled, medium hot griddle. One cup of corn flour may be used instead of stone ground whole wheat flour. These are very delicious.

Soups and Sprouts

ORIENTAL DISHES

STUFFING

SPROUTING

OATMEAL SOUP 800

- 1 large onion
- 3 stalks celery
- 3 Tbs oil
- 4 c water
- 1 c steel cut oatmeal
- 2 tsp vegetable salt
- 1 bouillon cube or
- 1 tsp soy sauce
- 1 tsp accent

Chop onion and celery fine and cook in oil until softened. Add oatmeal and cook, stirring constantly until it browns slightly. Pour in water, add vegetable salt and bouillon cube and bring to a boil. Reduce heat and let simmer for about 30 minutes. Makes about one quart.

MILLET SOUP 801

L. Daly

- 1 small cabbage*
- 1 quart vegetable stock or stock and milk
- 1 c Millet Meal
- ½ c chopped onion
- ½ c chopped celery
- ¼ c chopped parsley
- ½ tsp Smokene
- 2 Tbs butter or margarine

Cook onion and celery in butter with a little water until tender. Wet millet meal until it is all damp. Add cabbage, liquid, and millet to onion, celery mixture and let cook slowly until cabbage is tender. Stir in parsley and Smokene and salt to taste just before serving.

*A left-over cooked vegetable may be used in place of the cabbage.

FAVORITE PEA SOUP 802

Hazel R. Parcells, Ph.D.

- 1 c split peas
- 1 lg. onion (chopped fine)
- 2 Tbs oil (Soya)
- ½ tsp Summer Savory
- Dash cayenne
- Salt to taste

To 1 qt. water, add peas, onion and oil. Simmer for one hour or until tender. Add seasoning. Simmer 5 minutes. Serve hot.

SPLIT PEA VITAMIN SOUP 803

Ethel Spear

- 3 c split peas
- 2 bay leaves
- 4 Tbs oil
- 4 cloves garlic
- 3 Tbs soy sauce
- 1 med. onion (chopped fine)
- Salt to taste
- 3 c diced potatoes
- 1 c chopped celery (with leaves)
- 2 c chopped parsley

Soak peas. Add 3 qts. water and cook together with bay leaves, oil, garlic, soy sauce and onion. Salt. Cook until dissolved, then add potatoes, celery and parsley. Cook slowly until vegetables are tender. (about 20 imn.)

LENTIL SOUP 804

Hazel R. Parcells, Ph.D

- 1 c lentils
- 1 lg. onion
- ½ c celery leaves
- ½ c parsley
- 2 Tbs. oil (Soya)
- ½ tsp sweet basil
- Dash cayenne pepper
- Salt to taste.

Wash lentils and soak several hours. Chop very fine: onion,

celery leaves and parsley. Add vegetables and oil to lentils. Cook in water in which they were soaked. Simmer until tender. Add seasoning and simmer 5 min.

Hint: **804A**

Float buttered popcorn on top of most any soup. Tastes good and makes an attractive dish.

POTATO SOUP **805**

To 1 c hot milk, add 2 Tbs. Potato Flour. Use eggbeater. Add, salt, pepper, chopped or powdered onion and butter.

SOYA SOUP **806**

If you have 4 c of soup stock, take out ¼ c stock and mix it with ¼ c Soya Flour. Combine with the finished soup for the last few minutes of cooking before soup is served.

PUREE OF SOYBEAN SOUP **806A**

1 c soybean pulp (see Number 302)	1 c meat stock
1 Tbs finely chopped celery leaves	2½ c milk
2 Tbs chopped onion	1 Tbs flour
	1 tsp salt
	⅛ tsp pepper

Combine soybean pulp with celery, onion, and meat stock, and simmer slowly until the vegetables are tender. Then mix milk with dry ingredients and add to the cooked mixture. Heat and serve with crackers or toast.

POTATO FLOUR GRAVIES **807**

Stir Potato Flour into the hot fat before adding water or milk. It browns quickly and imparts a fine flavor to the gravy.

Brown Rice Flour, Gluten Flour, Rice Polish or Whole Wheat Flour also make excellent gravies. Generally use 4 Tbs flour to each pint of liquid.

SPROUTING

Vitamin-rich sprouts are certainly the most "living" food on earth. Sprouted seeds compare with meat in nutritive value, to fresh fruit in vitamin C properties, have no waste, are excellent raw or can be cooked if desired. Sprouts are economical since one pound of seed produces six to eight pounds of sprouts.

The vitamin content of seeds and grains is increased approximately five-fold in sprouting. Sprouted grains and legumes contain enough protein to be classed as "complete" and many of the proteins are predigested or changed to amino acids during the growing. Likewise, starch converts to sugar, making sprouts a quick energy food.

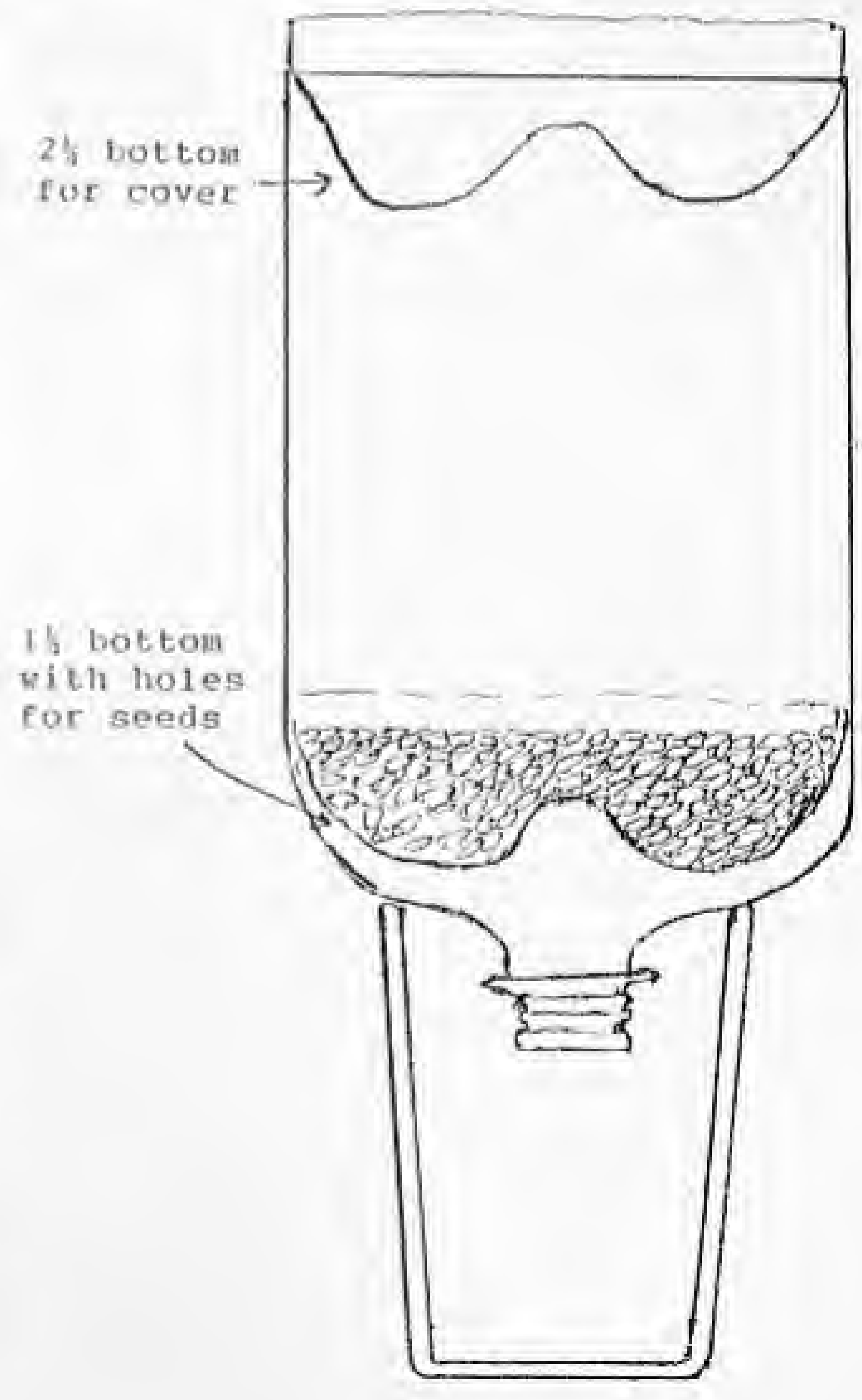
Seeds may be sprouted easily in the home. There are a few rules to remember: The container should be non-porous, such as plastic or glass. A porous pot or plate is apt to cause fungus or mold in the sprouts. A *constant humidity*, an *even source of water, exclusion of light* and *uniform temperature* are important to sprouting.

I am going to show you how to get 240 pounds of the most nutritious, filling and tasty food for only $7.50. This is what you get from 60 pounds of hard red winter wheat, bought at that general price range from any feed and seed store in the U.S. If they don't stock it, they will order it.

When sprouted for food, a seed will go from double to ten times its original size. The sprouted seed has more vitamins and minerals and much of its starch is turned into sugars. Unlike mung beans, those sprouted for Chinese dishes with a root at least an inch long, the wheat is sprouted until its root is no longer than the seed itself. Otherwise, it would be woody and indigestible. Even so, the bran and roughage will clean you out, guarantee you will never get colon cancer and you will never need a laxative.

There are all kinds of sprouters but I have designed the best and it costs nothing. It is made of two 2 liter soft drink bottles. Don't use those with the hard, black bottoms unless you want to pry them off. I use Classic Coke bottles.

Put a razor knife under the label of one, cut up its length and strip it off. Then



cut the bottoms off both bottles, one slightly over 1 1/4 inch and the other 2 1/4 inches. Take a needle or knife point and make several small holes in the small bottom. Now you have your sprouter and it should not have taken more than five minutes to make and will last a lifetime.

Then put four ounces of wheat in a glass and cover it with a little over twice its volume with water. Let it soak over night. Next morning drink the water. It is pleasant and full of vitamins and minerals.

Now force the smaller bottom with the pin holes down toward the neck of the bottle without the label. Pour the wheat in and then put the larger bottom inside the opening. Put the bottle, neck end down in a glass or jar.

Three or four times a day, pour lukewarm water over the seeds to flood them and let the water drain into the bottle. After 48 hours nearly every grain should have sprouted. Don't worry about the few unsprouted grains. They are edible.

Next, boil three cups of water in a sauce pan and add the sprouted grain. Cook for ten minutes, drain and put the cooked grain in a blender and add one cup of the cook water. (You could eat them without blending but they are chewy and not nearly so tasty. You could even eat them without cooking if you like roughing it.) After blending you will have a pound of cream of wheat, ready to eat. Put some sugar or honey and milk on it and you will have a large bowl of the most delicious cereal you have ever tasted. If you eat it all, you will be surprised at the quick and lasting energy you will get. With the sweetener and milk you have spent about five cents. It could be your whole breakfast. Think what you would save if that was all you ever ate for breakfast.

If you wanted it every day, you could make two sprouters and have a fresh batch each morning. You might also consider making four or five sprouters and add mung bean and alfalfa sprouts to your diet.

You could also dry the cooked grain in an oven at low heat and it will store indefinitely. You could even grind it in your Corona Grain Mill, put it in a baggy and take it camping. Adding boiling water would give you an instant breakfast.

Incidentally, you do not have to buy a whole bushel to start. You can buy it by the pound at your health food store, but not so cheaply. But when you buy a bushel, split it up into a dozen or so smaller batches and put it in tightly closed containers in case there is a weevil in the bushel.

WAYS OF SERVING SPROUTS

Sprouts of all kinds are an excellent addition to either fruit or vegetable salads. Use sprouts on all kinds of sandwiches to add texture plus vitamins and minerals. Alfalfa sprouts are especially good in sandwiches.

Sprouts may be added to soups, stews or casseroles just before serving or cooked the waterless way at low heat for 5 minutes, seasoned and served as a vegetable.

Gently saute sprouts with green pepper and onion and add to scrambled eggs.

Ground sprouts can be added to yeast bread*, muffins, pancakes or waffles.

*To be added at the time of the final kneading—just before shaping for the pans.

Use a liquefier to combine sprouts with fruits, vegetables or juices.

No end of variety and interest, as well as good nutrition, can be added to the daily diet with the use of sprouts.

SPROUTED WHOLE WHEAT BREAD 852

Into large mixing bowl pour 1 c lukewarm water. Add 2 Tbs dry active yeast. Let dissolve.

ADD:

2 c warm water	¼ c honey
1 Tbs salt	3 Tbs oil or margarine

Stir in 3½ c Unbleached Hard White flour.

Beat dough until elastic. Let this sponge raise. Keep temperature around 80° F.

To raise sponge add:

2 c sprouts that have been ground in meat grinder.

Work in about 2 c 100% Whole Wheat Flour. Knead until dough is smooth and elastic.

Place in oiled bowl. Cover. Let raise in warm place until double bulk.

Knead lightly, shape into loaves. Place in greased bread pans. Let raise until double bulk.

Bake in moderate oven at 375° F. for 25 minutes, 300° F. for 35 minutes.

Remove from pans, place on wire rack to cool. (If desired, all or a part of the wheat sprouts may be used whole without grinding).

SPROUTED WHEAT BALLS 853

2 c sprouted wheat	1 tsp salt
1 c almonds, walnuts or pecans	1 large onion
	2 Tbs oil
2 c bread crumbs	1 c milk

Put sprouts, almonds and onion through small blade of a meat grinder. Add crumbs, salt, oil. Stir in milk. Make into balls. Bake in oven on a greased cookie sheet or fry in a frying pan until golden brown. Serve with gravy. Top with parsley.

SPROUTED WHEAT CEREAL 854

Replace ¼ to ½ the cracked wheat or steel cut oats (or other ground cereal) with wheat sprouts. (separate the sprouts for easy stirring)

Proceed as directed for cooking ground grains, using slightly less water in cooking.

Alfalfa: Alfalfa is one of the easiest seeds to sprout, one of the tastiest and is certainly very nutritious. Alfalfa sprouts may be eaten plain or sprinkled over salads or used in soups.

ALFALFA SANDWICH 855

Spread favorite mayonnaise on rye bread. Add about a quarter inch thickness of alfalfa sprouts.

Serve either as open face or closed sandwiches. Other foods such as sliced tomato may also be incorporated in the sandwich.

STUFFED CELERY 856

Fill centers of cleaned celery stalks with Tbs of cream cheese. Sprinkle liberally with alfalfa or alfalfa-radish sprouts.

Lentils: Lentil sprouts have a unique taste and are very suitable for tossed salads.

COOKED BEAN SPROUTS 857

Chop one medium size onion and cook in frying pan in a little water until soft. Salt. When soft, add 4 c cleaned, drained, bean sprouts. Cook until almost soft. Add soy sauce and salt to taste. Serves four.

CHOP SUEY 858

Cook in frying pan with a little water:

1 large onion chopped, 1 c chopped celery and 1 c sliced mushrooms.

When soft add: 6 c cleaned, drained bean sprouts. Cook until almost soft. Add soy sauce and salt to taste. Serves six.

Allergy Recipes and Helpful Hints

BREADS
HOT CAKES & WAFFLES
CAKES & PASTRIES

Many persons, with a mild allergy to wheat, have found the following method of preparing bread to be beneficial. The reason is that the fermentation takes place in the sponge rather than inside the body. This 72 hour sponge method also helps keep down weight.

BREAD SPONGE, 72 HOUR PROCESS 900

Sponge:

- 2 potatoes or #108A
- 2 Tbs brown sugar
- 2 tsp salt
- 1 Tbs active dry yeast
- 1 c Whole Wheat Flour

Cook potatoes in 1 pt. water and let cool.

Mash and add sugar and salt.

Dissolve yeast in ¼ c lukewarm water and let stand 15 minutes without stirring.

Stir in 1 c Whole Wheat Flour and place in 1 quart jar. (cover, but not completely) Set aside 72 hours at room temperature. Stir down each time the mixture reaches top of jar; repeat until it stops working.

After 72 hours, keep in ice box until ready to use.

- 2 c sponge
- ½ c oil
- ½ c brown sugar
- 1 pt. warm water
- 6½ c Whole Wheat Flour

Combine, knead, varying amount of flour as needed, place in oiled bowl to rise.

Lightly work down, place in pans, let rise a little and bake at about 350° F. until done. (about 50 to 60 minutes, depending on the size of loaves).

RYE BREAD 901

(wheat-free)

- 2 c milk
- 1 Tbs oil
- 2 tsp salt
- 1 Tbs active dry yeast
- 4½ c Rye Flour

Heat milk to simmering, pour over oil in bowl and add salt. When LUKEWARM dissolve yeast in mixture. Sift the Rye Flour, measure and resift into above. Add just enough Rye Flour to make a stiff dough. Stir for about 5 minutes, cover with towel and let rise for about 2 hours in a warm place. Punch down and turn onto a board lightly dusted with Rye Flour. Knead 10 minutes until dough becomes springy. Shape into loaves, cover with towel and let rise until dough begins to lift the towel. Place in a pre-heated oven and bake at 300° F. for 1½ hours with a pan of hot water placed on shelf directly beneath pans of bread.

BROWN RICE FLOUR BREAD 902

(with baking powder)

- 2 c Brown Rice Flour
- 3 tsp baking powder
- ½ tsp salt
- 2 Tbs oil
- 1 Tbs Wheat Germ (optional)

Combine all dry ingredients and sift. Blend in oil and make into a thin batter with about 1 c water. Pour into a shallow greased pan and bake in pre-heated oven at 400° F. for 1 hour or until done.

BROWN RICE FLOUR BREAD 903

(with yeast)

- 6 c Brown Rice Flour
- ½ c Wheat Germ (optional)
- 2 tsp salt
- 4 Tbs brown sugar
- 4 Tbs oil
- 1½ or 2 Tbs active dry yeast

Thoroughly mix dry ingredients. Dissolve yeast in 3 c warm water and add oil and mixed dry ingredients. Mix well, add more warm water to make soft mixture. Place in greased muffin tins or bread pans, filling about ¾ full. Let stand 45 minutes. Bake in pre-heated oven 30 minutes, or until bread is brown crusted and cracks on top.

SOYA-RICE FLOUR BANANA BREAD 904

(wheat-free)

- 1 c brown sugar
- ¼ c oil
- 2 eggs, well beaten
- ½ c Soya Flour
- 1 tsp soda
- 3 ripe, mashed bananas

3 Tbs milk — 1 tsp salt
1½ c White Rice Flour

Combine all ingredients. Put in warm place ½ hour before baking. Place in bread pan and bake at 400° F. for 1 hour.

SOYA MUFFINS 905

(wheat-free)

2 eggs, separated	2 tsp baking powder
3 Tbs brown sugar	pinch of salt
1 Tbs grated orange peel	1 c sweet milk
1 Tbs melted butter or margarine	¼ c raisins
	¼ c chopped walnut meats
1½ c Soya Flour	

To beaten egg yolks, add brown sugar and grated orange peel, then add melted butter.

Add flour, baking powder and salt sifted together, alternately with the milk. Add stiffly beaten egg whites. Then add raisins and chopped walnut meats.

Bake at 325° F. for 35 minutes.

Hint: see #917A.

MILLET-BARLEY-SOYA MUFFINS 905B

(wheat-free)

½ c Millet Flour	3 tsp baking powder
½ c Barley Flour	⅓ c Water
¼ c Soya Flour	1 Tbs Oil
½ tsp salt	4 Tbs Honey
1 egg	

Sift flours before measuring. Mix dry ingredients. Beat egg and add oil, honey and water. Blend with dry ingredients, mix lightly. Bake at 375° F. for 25 minutes.

BARLEY GRIDDLE CAKES 906

(wheat-free)

1 c Barley Flour	1 egg, beaten
2 tsp baking powder	1 tsp oil
¼ tsp salt	

Combine ingredients with 1 c cold water. Mix thoroughly adding more water if necessary. Bake on hot griddle.

Hint: see #917A.

SOYA RICE WAFFLES 907

(wheat-free)

E. B. Laursen

⅓ c Soya Flour	½ tsp salt
⅔ c Brown Rice Flour	¾ c cream or water
1 Tbs baking powder	1 egg, separated
3 tsp brown sugar	2 Tbs oil

Combine well-beaten egg yolk with ½ c sifted dry ingredients, then add oil. Alternately add remaining sifted dry ingredients and liquid. Fold in stiffly beaten egg whites.

BROWN RICE FLOUR WAFFLES 908

(wheat-free)

2 c Brown Rice Flour	2 eggs
3 tsp baking powder	1½ c milk
1 Tbs brown sugar	6 Tbs oil
¼ c chopped walnuts (optional)	

Beat eggs and milk together. Combine dry ingredients and add to egg and milk. Add oil.

SOYA-RICE FLOUR COFFEE CAKE 909

(wheat-free)

½ c Soya Flour	2 eggs, beaten lightly
1½ c White Rice Flour	1 c milk
4 tsp baking powder	1 tsp cinnamon
½ tsp salt	1 Tbs vanilla
4 Tbs brown sugar	

Bake in a flat pan at 350° F. for 35 minutes.

BANANA SPICE CAKE 909-1

(wheat-free)

Paula Simonds

2½ c Brown Rice flour (sifted)	1 tsp vanilla
2½ tsp baking powder	1¼ tsp cinnamon
½ tsp soda	½ tsp nutmeg
¾ tsp salt	1½ c (about 4) ripe bananas
⅛ tsp cloves	½ c oil
2 eggs	1¼ c brown sugar
	3 Tbs sour cream

Sift together: flour, baking powder, soda, salt and spices.

Add oil to sugar gradually. Add eggs one at a time. Next add sour cream and vanilla.

Add bananas (mashed) alternately with flour. Pour into 2 well greased 9 inch layer cake pans. Bake at 375° F. 25 min. or until done.

SOYA, CAROB CUP CAKES 910

(wheat-free)

½ c brown sugar	1 c Soya Flour
¼ c oil	1 tsp baking powder
2 eggs, separated and beaten	2 Tbs Carob Powder
⅓ c milk	1 tsp vanilla

Thoroughly cream oil and sugar; add beaten egg yolks. Add flour and baking powder alternately with liquid to mixture. Then add beaten egg whites, carob and flavoring. Bake at 350° F. until done.

SOYA CAKE 910A

(wheat-free)

3 c Soya Flour	½ tsp Vanilla Extract
3 tsp baking powder	4 Eggs, well beaten
½ c Brown Sugar	⅓ tsp Soda
3 drops Almond Extract	½ tsp Salt
½ tsp Lemon Extract	1 c cream
⅓ c Orange Juice	1 c milk (approximately)

Sift dry ingredients together except sugar and soda which are to be rubbed smooth with the eggs. Add to the egg mixture the orange juice and extracts, then milk & cream. To this add the sifted ingredients. Bake at about 350 degrees for about 45 minutes.

QUICK RAISIN NUT BREAD 910B

(wheat-free)

½ c seedless raisins	½ tsp salt
½ c walnut meats	¼ tsp cinnamon
3 tsp baking powder	1 egg
2 c sifted rye flour	2 Tbs vegetable oil
½ c sweet milk	½ c honey

Chop nuts coarsely and mix with raisins. Sift flour. Sift portion of flour over raisins and nuts and remainder with baking powder, salt and cinnamon. Beat egg, add honey and vegetable oil. Add dry ingredients alternately with milk, beating after each addition. Add raisins and walnut meats last. Turn into a greased loaf pan and bake in a moderate oven, 350° F. for about one hour. After removing from oven, let stand in pan for a few minutes, then remove to cake rack and cool.

POPCORN BALLS 911

1 c sorghum	1 small piece butter
1 c brown sugar	popped corn

Cook sorghum and sugar until hard ball stage when dripped in cold water. Add butter and pour over popcorn. Stir and make into balls. Peanuts may be added.

RICE FLOUR PIE CRUST 912

for one 9 inch pie

1 c Brown Rice Flour	4 Tbs margarine
1 Tbs. Potato Flour	
½ tsp. salt	4 Tbs ice water

Combine rice flour, potato flour and salt. Cut in margarine with pastry blender to a fine texture. Add ice water to form a soft dough. Pat dough evenly into pie pan. Bake 15 minutes or until nicely browned in 425° oven.

WHOLE RYE FLOUR WAFFLES 913

(wheat-free)

3 eggs	1 Tbs dark brown sugar or Honey
1½ c milk	

½ tsp salt	2 Tbs melted butter
	1½ c Whole Rye Flour

Beat egg yolks well, add ingredients in order given. Beat egg whites until stiff but not dry and fold into batter. Bake in hot waffle iron. May also be used as pancakes.

Remarks: 1 egg is equal in leavening power to ½ tsp baking powder.

BARLEY MUFFINS 913A

(wheat-free)

2 c Barley Flour	½ c dark brown sugar
2 tsp baking powder	2 eggs
1 tsp baking soda (scant)	¼ c cream (add water if
pinch of salt	moist batter is desired)

Sift dry ingredients together. Add combined eggs and liquid, beat thoroughly. Makes 1 dozen muffins. Bake at 400 degrees for 25 minutes.

BROWN RICE FLOUR MUFFINS 913B

(wheat-free)

1 c Brown Rice Flour	¼ tsp salt
(sift before measuring)	1 egg (beaten)
1½ tsp baking powder	½ c milk
¼ c dark brown sugar	4 Tbs oil

Sift dry ingredients together. Beat egg, add milk and oil, blend into dry ingredients, but do not beat. Bake in well greased muffin tins for 15 minutes in 450° oven. This recipe makes 6 large or 12 small muffins. May also be made and shaped as a loaf of bread.

HONEY MUFFINS 913C

(wheat-free)

2 c barley flour	2 Tbs vegetable oil
2 tsp baking powder	2 Tbs honey
1 tsp soda	(overflowing)
½ tsp salt	1 tsp vanilla
¼ c creamed or canned	2 eggs
milk	½ c dark brown sugar

Combine milk, vegetable oil, honey and vanilla in bowl. Add beaten eggs and sugar. Mix well. Sift dry ingredients and add to liquid mixture. Pour or spoon into greased muffin tins. (Mixture is the consistency of cookie dough.) Makes one dozen. Bake at 400° F for 20 minutes.

If you like a cookie with a cake texture, add coconut, nuts, raisins or dates to the above recipe and drop onto a greased cookie sheet and bake 8 minutes at 375° F.

HELPFUL HINTS 914

With a little experience, Whole Wheat Flour (hard wheat) or Pastry Whole Wheat Flour (soft wheat) may be used in cake baking, pie crusts, breads and rolls or for any purpose white flour is used. The better flavor and nutritional value will reward you for your effort in learning how to use them.

To measure honey, first measure shortening and then measure honey in the same measuring unit.

One of our customers tells us her children now approach their whole grain breakfast cereals with much enthusiasm. She moulds cooked cereals into figures and animals with cookie cutters.

Worth Trying:

Sprinkle chopped Hulled Sunflower Seed over grated carrot salad.

Replace approximately 10% wheat flour with Sunflower Seed Meal in all baking—especially cakes, to make more attractive. Note the high nutritive values on "composition of foods" chart.

Add handful of Hulled Sunflower Seed into cereals while cooking.

1 c Soya Grits, Wheat Grits, Barley Grits or Steel Cut Oats added to 1 c boiling water and soaked until all the water is absorbed is a delicious addition to: breads, chili, cookies, soups, casseroles meat loaf or patties. Keep on hand in refrigerator for instant use.

SOUR MILK 915

SOUR MILK—may be made from sweet milk by adding 2 tsp lemon juice or vinegar to 1 c sweet milk. Keep in a warm place or stir over very low heat a minute or two until the milk curdles.

SIFTING 916

SIFTING—Except for bread and rolls, sift flour once before measuring. For cakes, cookies and pies, resift flour 2 or 3 times after measuring. The purpose of sifting is to obtain a lighter texture—not to remove anything. Coarse bits of grain and bran flakes may be poured into bowl with sifted flour. Coarser flour or meal should not be sifted.

FOR MUFFINS 917A

For Muffins—try adding Hulled Sesame Seed to greased muffin tin before adding batter—also sprinkle on top.

SKIN CLEANSER 918

OAT FLOUR is successfully used by many to cleanse and soothe tender, sensitive skin. It also helps relieve dry, itchy, scaly skin caused by soap or hard water.

Methods as described by Doris Hopwood, Nutritionist:

"Wet hands and face—put about one Tbs of Oat Flour in palm—add enough more water to make a smooth paste—then smooth over the hands and face. Leave on for a short time—a minute or two—and rinse off."

"For treating severe cases of poison oak or poison ivy, swish 1 c of oat flour in a small cotton bag in warm bath water until water is gooey—leave patient in bath for 10 minutes. Take patient out, pat dry and apply contents of bag to affected parts and let dry. Repeat with fresh oat flour until relieved."

(Numbers indicate where product is used in recipes)

DESCRIPTION OF PRODUCTS OF EL MOLINO MILLS

ALFALFA SEED—Untreated, select quality alfalfa seed for sprouting and tea. High mineral content. See directions for preparation of sprouts or tea.

505-850-855-856

ARROWROOT STARCH—Finely ground tuberous rootstocks of the arrowroot. The nutritious starch yielded by this plant may be used in place of corn or tapioca starches, but is reputedly the only starch that has an alkaline ash with calcium content. Used as a carbohydrate for milk modifying in infant feeding.

From United States Dispensatory
23rd Edition

Arrowroot starch occurs as a light white powder. It provides a very mild, easily digested dietary article well adapted for the sick and convalescent and particularly suited because of its demulsion properties to bowel complaints. For use of the material, it should first be formed into a smooth paste with a little cold water or milk, then hot water or milk added gradually with brisk agitation. The preparation may then be suitably flavored and sweetened.

HULLED BARLEY—A natural white barley with only the outermost "hull" or "chaff" removed. Neither pearled nor polished. A flavorful addition to soups, cereals, casseroles, etc. 400

BARLEY GRITS—whole, hulled barley, cracked into 6 to 8 separate pieces, free from flour. A flavorful addition to

soups, cereals, casseroles or in meat loaves, hamburgers and patties as a meat extender.

401-917

BARLEY FLOUR—A finely ground hulled barley for blending with other flours in baking bread, muffins, cakes, cookies, hotcakes, thickening, etc. Much used in infant feeding. An excellent substitute in restricted diets.

100C-905B-906-913A-913C

BUCKWHEAT GROATS—Whole, roasted buckwheat used for cereal, stuffing, soup, pudding and favorite Jewish dishes: Blintzes, Knishes, Varnishkes, etc.

309-310-311-312-313-314-400

BUCKWHEAT FLOUR—Pure eastern buckwheat flour with nothing added. Makes real "Old Time" hotcakes and waffles. Add to scrapple.

700-701

CAROB POWDER—"St. John's Bread", "Boecksur", "Honey Locust", "Locust Bean", etc. Finely ground select Carob pods from budded trees. Ideally suited for confections, hot or cold milk drinks, cakes, icings, cookies, fudge, syrup. Carob powder is alkaline, high in calcium, rich in natural sugars, low in starch, low fat (2% fat as compared to 52% fat in chocolate), and is delicious used with equal parts of powdered skim milk for all kinds of "Confections without Objections". Surprise the family with a batch of "Brownies" today.

100A-100C-200A-202A-203-204-204B-205-205B-205C-206-207-207A-207B-210-211-211A-250-500-501-501A-501B-501C-506-702-910

CORN (WHOLE) White or Yellow—Midwestern select corn for home grinding, hominy or parching. Offered in various grinds for every use.

CORN MEAL White or Yellow—Cool, slow ground on buhr stones from select corn, to medium meal consistency. (An extra coarse grind is offered in yellow corn meal only). Ground the old fashion' way for old fashion' dishes. All the corn germ and corn flour is left in so that it is not necessary to add other flours to prevent crumbling. For: cornbread, mush, fried mush, hotcakes, tamale pie, fritters, scrapple, etc.

100A-100C-115-115B-116-117-118-119-308-315-401-405-700-703-705

CORN FLOUR White or Yellow—Whole ground to a fine consistency from select midwestern corn. Used in breading, breads, gems, hot cakes, waffles and many other uses mixed with various flours.

100A-100C-700A

HOMINY GRITS—Southern Style "Grits" made from select white corn. Degermed and hulled.

401

POP CORN, Yellow—Highest quality. Pops large and tender. Try ours and taste the difference.

804A-911

FLAXSEED—Pure "Druggist" quality, untreated flaxseed. Add to cereals before cooking. Aids in relief of constipation. Reputedly contains valuable unsaturated fatty acids.

400-503

FLAXSEED MEAL—Flaxseed (described above) ground to medium meal consistency. Add to cereals before cooking and blend with other flours in baking. Aids in relief of constipation. Reputedly contains valuable unsaturated fatty acids.

100C-135

GARBANZOS (CHICK PEAS)—Untreated, large cooking variety Garbanzo Beans. For soups and casseroles. Alkaline tendency.

320

LENTILS—Untreated, large, cooking variety Lentils. For soups and casseroles. Alkaline tendency.

319-804-856

HULLED MILLET—Untreated (Proso) Millet, freshly hulled. Alkaline forming and easily digestible. Absorbs from 3 to 4 parts of liquid while cooking. In a steamer it cooks light and fluffy for delicious cereal, puddings or casseroles. An excellent meat extender of good quality protein.

321-400-406

MILLET MEAL—Medium grind meal from Hulled Millet. Use equal parts millet meal with corn meal in tamale pie; or, mush for cereal or for frying. Millet has an alkaline ash and tends to balance the ash of acid cereals. The unusually high quality of millet protein and lecithin make it an excellent meat extender.

100C-216-308-401-801

MILLET FLOUR—Pure, hulled millet (White Proso) finely ground. Alkaline-forming, easily digestible. Especially suited for breads, etc. in diets restricted of wheat, rye, etc. Millet is particularly high in Vitamin B-2, Potassium, Lecithin, Silicon, Iron, Magnesium, Calcium, Phosphorus and essential Amino Acids.

905B

MUFFIN MIX—for hotcakes, waffles, cookies, dumplings, breading, etc. A self-rising mixture of 8 unrefined flours: whole wheat, bran, old fashion' dark brown sugar, soybean, leavening*, rye, corn, wheat germ, barley, oats, salt, rice polish, buckwheat. A most delicious mixture constantly gaining in popularity.

*A tartrate base leavening (a recrystallized product from the juice of grapes) absolutely free from alum, ammonia or lime. (The exact combination is confidential; however, is added in conformance with good health principles).

100C-120-121-200A-210-307

MUNG BEANS—Untreated, select quality Mung Beans for sprouting or cooking. Sprouting reputedly increases B and C vitamins several times over amount contained in parent seed. Sprouts add flavor to salads, omelets, sandwiches and oriental dishes. See directions for preparation of sprouts.

857-858

OAT GROATS—Untreated, natural, hulled oats, with only the outermost "hull" or "chaff" removed. For grinding or cereal. Excellent when blended in equal amounts with Red Cereal Wheat when cooking as a cereal.

400-403

STEEL CUT OATS—Natural, unrefined oat groats cut into 2 to 3 small cubes for a tasty, chewy cereal. For cereal, or for variations, blend with cracked wheat or hulled millet.

401-404-800-917

ROLLED OATS—Old fashion' type rolled oats—large separate flakes. Cooks into large chewy flakes when properly steamed. Use for cereal, cookies as you would other type oats. For added flavor in cookies, toast lightly in oven, then crumble between hands.

110-135-211A-214-220-221-401

SCOTCH OATMEAL—Natural, unrefined oats ground "Scotch Style" for Scotch Oatcakes, griddlecakes, cookies, scones, porridge and for blending with other flours in baking.

100A-100C

OAT FLOUR—Finely ground to flour from oat groats. For blending with other flours in baking bread, muffins, cakes, hotcakes, thickening. Rolled Oats may be added to produce variety in texture. Much used in infant feeding. An excellent substitute in restricted diets. Also used to cleanse & soothe tender sensitive skin. Helps relieve dry, itching, scaly skin caused by soap or hard water.

918

GREEN SPLIT PEAS—Untreated, natural green split peas of select quality, for soups.

802-803

POTATO FLOUR—Whole, Idaho potatoes, steam cooked and dried (including peel). One pound of potato flour is equal to 5 pounds potatoes. Compact and convenient with all the flavor of good potatoes. Use in soup, breads, gravies, hotcakes, muffins, breading, etc. Blend with other flours before adding liquids to prevent lumping.

This FINE grind potato flour must be blended with the flour or other dry ingredients, such as sugar, before mixing into the dough. Another method is to cream the potato flour with the shortening, which produces excellent results.

100A-100C-108A-112-200A-
318-405-604-605-608-805-807

NATURAL BROWN RICE—Finest quality, California Pearl rice. Hulled by a special technique to fully preserve all the germ. (The germ at the tip end of the kernel is often damaged in hulling by common methods used.) All the polish and bran as well as all the rice germ remains for maximum natural goodness. Unsurpassed when properly cooked. Unpolished rice used in place of potatoes is a welcomed change. The protein is of high quality.

306-306A-306B-306C-306D-
306E-306F-400-606-607-611

BROWN RICE FLOUR—Rice (described above) reduced to flour for blending with other flours in all baking and breading. A "must" added to hotcake and waffle batters.

One of the best flours used in allergy or restricted diets. With skill, brown rice flour may be used without any other flours in any baking with your favorite recipes. Unsurpassed when made into a batter for breading.

100C-126-200A-250-604-704-807-902-
903-907-908-909-1 -912-913B

WHITE RICE FLOUR—Polished white rice reduced to flour. Use same as you would Brown Rice Flour.

904-909

RICE BRAN—Outer bran layers of brown rice. A by-product from polishing natural rice into white rice. Use as you would rice polish and wheat germ.

100C-200A

RICE POLISH—Inner bran layers from brown rice. A by-product from polishing natural rice into white rice. Contains high concentration of minerals and vitamins often absent from refined foods. Add to practically all foods as you would wheat germ. Particularly popular in "health cocktails". Extremely valuable in calcium in a form easily assimilated.

100C-116-200A-506-807

RYE (WHOLE)—Dark Northern rye for home grinding and cereal. Offered in several grinds for every use.

400

RYE GRITS—whole rye cracked into 6 to 8 separate pieces, free from flour. Used as cereal or mix with other grits or meals for adding to breads.

100C-100E-401

RYE MEAL—"Pumpernickel" type rye whole ground to consistency of a coarse corn meal. Blend with other meals or flours in baking.

100A-100D-105

RYE FLOUR—Whole ground to fine consistency from dark northern rye. For: breads, sour doughs, scrapple, rolls and many other uses mixed with various flours.

100A-100D-106-131-901-910B-913

HULLED SESAME SEED—Untreated, freshly hulled white Sesame Seed. Add to oiled bread pans and muffin tins before adding dough or batter. Sprinkle on top of moist hotcakes, waffles, breads, muffins, cookies when batter or dough is first put in container for baking. Use in liquefiers.

100C-100E-101A-207-212-215-220-702-917A

SESAME SEED MEAL—Slow, cool ground Hulled Sesame Seeds. Contains full oil content. High in lecithin, protein, minerals and vitamins. Blend in with: cookies, cake, mashed potatoes, cooked vegetables and cereals. Combine with lemon and spices for salad dressings. Place in liquefier with cocoanut, carob powder or juices for "Health Cocktails" or liquefy with water and honey for sesame milk. Keep refrigerated in tightly closed plastic bag.

508

SEVEN GRAIN CEREAL—A delicious combination of 7 unrefined grinds of: wheat, corn, barley, oats, rye, soybeans, bran and rice bran. Raisins or dates provide adequate natural sweetening when added. A most delicious and nourishing breakfast of increasing popularity. For: cereal, pudding, soup, casseroles, loaves & patties as a meat extender. Replace small amount of fl·.r when baking, with cooked cereal.

401

SOY BEANS—Easy cooking—Table variety. The Soy Bean combines more concentrated food elements than any other common food. Compare the nutritive values on "Composition of Foods" chart, and note these features: extreme high protein, 40 to 45%; low starch, less than 2%; easily digestible oils; rich in lecithin; "contains all essential Amino Acids" (Osborne & Mendel); has an alkaline ash and tends to balance the acid ash of acid forming cereals. The Soy Bean is concentrated, wholesome nourishing and economical. It is rich in and is also a cheap source of protein of high quality, oil, minerals and practically all the known vitamins when prepared in various forms. Serve: cooked, baked, toasted, sprouted, as milk, in soups and a thousand taste tempting ways. For more complete methods of preparation obtain: "The Useful Soybean," by Mildred Lager.

301-301A-301AA-301B-302-302A-302B-302C-302D
303-305-305B-806A-857-858

SOYA GRITS—Lightly toasted soya beans cracked into 8 to 10 separate pieces, free from flour. As like soya meal it is ready to eat except for softening, and therefore should be soaked as described for soya meal and added to numerous ready prepared cereals for added nourishment or to many meat dishes as a meat extender or in place of meat.

100C-219-221-318-401-917

SOYA MEAL—is ground to the consistency of a coarse corn meal. For improved flavor and nourishment and for alkaline balance soak with 2 parts of boiling water until all moisture is absorbed. Keep in refrigerator to be added to meat loaves, patties, croquettes as a meat extender.

100A-100C-318

SOYA FLOUR—is recommended for home consumption in preference to Soy Bean Flour (raw). Soy beans for all El Molino Soya products have been lightly toasted to aid assimilation and is designed to preserve full nutritional value. Soya products have a slightly sweet flavor somewhat resembling freshly crushed nuts. Soya Flour imparts a smoothness and richness in all products in which it is used. For improved flavor and nourishment, replace up to 1 part soya flour to five parts wheat flour wherever wheat flour is used.

100A-100C-101-107-107A-129-200A-201B-
202D-214-218-806-904-905-905B-907-
909-910-910A

SOYA POWDER—is the same as soya flour except that it is more finely ground for milk and other liquid uses.

207A-504-507

SOY BEAN FLOUR—(Raw) Select whole raw soy beans reduced to flour.

HULLED SUNFLOWER SEED—Large, tasty meats from giant size, select sunflowers, freshly hulled. Can't be beat as appetizers, just as it comes from the bag. May be toasted with oil or butter and salted, for appetizers. Add to cereals while cooking, cookies, salads, patties, etc. After pouring waffle batter on iron, sprinkle sunflower seeds on top before closing lid.

Good and Good for you.
110-207-321-404-702-917-917B

SUNFLOWER SEED MEAL—Ground sunflower seed meats. Contains full oil content. Blend in with: cookies, cake, mashed potatoes, spreads, cereals, and "health cocktails." Improves flavor of all baked dishes. Mixes to advantage with flour in most all bakings, when replacing flour up to 50%. A characteristic is its quick baking. In soup it needs only just heating.
100C-127-200A-914

RED CEREAL WHEAT—Select quality, hard Montana and North Dakota spring wheat. Grown in healthy soils of high mineral composition where the land is allowed to rebuild through a long range rotation plan. In discing under summer fallow, natural organic processes take place and humus is conserved. All El Molino hard wheat products are made with this wheat. The price of wheat is governed mostly by its protein content. Note the premium protein of El Molino wheat as compared with high protein spring wheat listed by the U. S. Department of Agriculture in "Composition of Foods" chart. Its premium quality is evidenced by its Alkaline ash.
316-317-400-402-403-850-850A

CRACKED WHEAT—Red Cereal Wheat cracked into 4 to 6 separate pieces, free from flour. For: cereal, meat loaf, casseroles, soups, hamburgers, patties, etc.
100C-100E-401-404

WHEAT GRITS—Red Cereal Wheat cracked into 6 to 8 separate pieces, free from flour. For: cereal, meat loaf, hamburgers, patties, etc.
100C-105-401-917

WHOLE WHEAT FLOUR—Cool, slow ground on buhr stones from hard Red Cereal Wheat described above offered in "Fine" or "Medium" grinds. Absolutely nothing is removed. All the bran and germ is reduced to flour consistency. For: breads, rolls thickening, hotcakes, etc. Use in place of white flour for all baking except for pastries. For pastries use Pastry Whole Wheat Flour.

100-106-107-108-112-113-114-
122-123-124-128-129-130-134-135-
201-202B-203-203-1-203-2-208A-211-212-
310-311-315-600-610-705-706-
807-852-900

GRAHAM FLOUR—a whole wheat flour with the inner part of the kernel ground to the consistency of white flour and the bran layers left flakey and coarse. For: bread, rolls, gems.
129

PASTRY WHOLE WHEAT FLOUR — Finely ground whole, soft, white pastry wheats. Use in place of all white flour in pastry baking including pies, cookies, waffles, cakes, etc. 2 or 3 extra siftings after measuring assure success in lighter cakes.

111-125-126-127-128-200-201-201B-
202-202D-203-3 -204-206-
208-211A-214-215-215A-217-218-219-
220-221-222-702-703

BRAN FLAKES—(Red) Outer bran layer as it naturally comes from hard, red wheat. Used in muffins, cereals, breads, health drink, etc.

100C-105-125-502

WHEAT GERM—Untreated, natural embryo of select wheat—ready to eat. Especially delicious for breading fish and other meats; omelets, or in cookies. Add wheat germ to practically all foods for your best source of valuable natural vitamins. Refrigerate after opening bag.
100A-100B-100E-101-116-123-
124-129-200A-201B-208-213-
213A-215-218-219-221-305-317B-318-
405-604-700A-902-903-912

WHEAT GERM FLOUR — Finely ground pure, raw wheat germ. Approximately 2% wheat germ flour added to refined flour recipes restores the germ removed in milling (white flour). Especially suited to add to cakes and pies, as well as all health "cocktails." Refrigerate after opening bag.

WHEAT GERM & MIDDLINGS—"Scalp of the Sizings" or "Caltech". Made from the part of the wheat containing the germ and fine bran particles. Consists of approximately 17% pure wheat germ,. Replace for part of flour in baking. A quick-cooking cereal.
100C-401

"UNBLEACHED" WHITE FLOUR (HARD WHEAT)—A refined flour from hard wheat. Absolutely no bleaching, maturing, nor preserving chemicals have been used in this flour. It is refined without chemical treatment and is therefore a "live" food, cream colored with much flavor. It is intended for use by those not desiring whole wheat flour, who are opposed to using "commercial" type flours. For: breads and all purpose use except for cakes.

100A-100C-101-107-107A-110-112-
115-116-129-131-135-
211-212-310-311-600-700-852

"UNBLEACHED" WHITE PASTRY FLOUR (SOFT WHEAT)—A refined flour from soft wheat. Processed identical to "Unbleached" hard wheat flour described above. For: pies, cookies cakes and general pastry uses.

GLUTEN FLOUR—is a low starch flour made by washing the starch from high-protein wheat flour. The gluten is dried and ground. (Note recipe in gluten section for preparing gluten from whole wheat flour.) When using gluten flour, more soya, rye or other specialty flours can be used in baking breads, hotcakes, etc. Excellent for gravies.
100B-100C-108-109-110-135-600-807

FOOD AND NUTRITION BOARD, NATIONAL RESEARCH COUNCIL
RECOMMENDED DAILY DIETARY ALLOWANCES,[1] REVISED 1958

DESIGNED FOR THE MAINTENANCE OF GOOD NUTRITION OF HEALTHY PERSONS IN THE U.S.A.

(Allowances are intended for persons normally active in a temperate climate)

	Age Years	Weight Kg. (lb.)	Height Cm. (in.)	Calories	Protein Gm.	Calcium Gm.	Iron Mg.	Vitamin A I.U.	Thiam. Mg.	Ribo. Mg.	Niacin[2] Mg. equiv.	Asc. Acid Mg.	Vitamin D I.U.
Men........	25	70(154)	175(69)	3200[3]	70	0.8	10	5000	1.6	1.8	21	75	
	45	70(154)	175(69)	3000	70	0.8	10	5000	1.5	1.8	20	75	
	65	70(154)	175(69)	2550	70	0.8	10	5000	1.3	1.8	18	75	
Women.....	25	58(128)	163(64)	2300	58	0.8	12	5000	1.2	1.5	17	70	
	45	58(128)	163(64)	2200	58	0.8	12	5000	1.1	1.5	17	70	
	65	58(128)	163(64)	1800	58	0.8	12	5000	1.0	1.5	17	70	
	Pregnant (second half)			+ 300	+ 20	1.5	15	6000	1.3	2.0	+ 3	100	400
	Lactating (850 ml. daily)			+ 1000	+ 40	2.0	15	8000	1.7	2.5	+ 2	150	400
Infants[4].....	0-1/12[4]				See								
	2/12-6/12	6(13)	60(24)	kg. x 120	Footnote	0.6	5	1500	0.4	0.5	6	30	400
	7/12-12/12	9(20)	70(28)	kg. x 100	4	0.8	7	1500	0.5	0.8	7	30	400
Children......	1-3	12(27)	87(34)	1300	40	1.0	7	2000	0.7	1.0	8	35	400
	4-6	18(40)	109(43)	1700	50	1.0	8	2500	0.9	1.3	11	50	400
	7-9	27(60)	129(51)	2100	60	1.0	10	3500	1.1	1.5	14	60	400
	10-12	36(79)	144(57)	2500	70	1.2	12	4500	1.3	1.8	17	75	400
Boys........	13-15	49(108)	163(64)	3100	85	1.4	15	5000	1.6	2.1	21	90	400
	16-19	63(139)	175(69)	3600	100	1.4	15	5000	1.8	2.5	25	100	400
Girls........	13-15	49(108)	160(63)	2600	80	1.3	15	5000	1.3	2.0	11	80	400
	16-19	54(120)	162(64)	2400	75	1.3	15	5000	1.2	1.9	16	80	400

[1] The allowance levels are intended to cover individual variations among most normal persons as they live in the United States under usual environmental stresses. The recommended allowances can be attained with a variety of common foods, providing other nutrients for which human requirements have been less well defined.

[2] Niacin equivalents include dietary sources of the preformed vitamin and the precursor, tryptophan. 60 milligrams tryptophan equals 1 milligram niacin.

[3] Calorie allowances apply to individuals usually engaged in moderate physical activity. For office workers or others in sedentary occupations they are excessive. Adjustments must be made for variations in body size, age, physical activity, and environmental temperature.

[4] The Board recognizes that human milk is the natural food for infants and feels that breast feeding is the best and desired procedure for meeting nutrient requirements in the first months of life. No allowances are stated for the first month of life. Breast feeding is particularly indicated during the first month when infants show handicaps in homeostasis due to different rates of maturation of digestive, excretory and endocrine functions. Recommendations as listed pertain to nutrient intake as afforded by cows' milk formulas and supplementary foods given the infant when breast feeding is terminated. Allowances are not given for protein during infancy.

APPROXIMATE COMPOSITION OF FOODS, 100 grams, Edible Portion

Household measurements (in terms of cups and spoons) are shown in grams to enable you, thru simple ratio, to determine any specific data desired in terms of cups or spoons.

For easier use, we have avoided cluttering our tables with reference numbers.

FOOD AND DESCRIPTION (Dry)	CALORIES per 100 gm	WATER gm	PROTEIN gm	FAT gm	FIBER gm	CARBO-HYDRATES gm	ASH gm	PRINCIPAL MINERALS per 100 grams	PRINCIPAL VITAMINS per 100 grams
ARROWROOT STARCH 1 Tbs=8 gm	362	12	.5	.2	.1	86.9	.3	25. mg Calcium 9.3 mg Potassium 20. mg Silicon	
ALFALFA SEED ½ c=105 gm	371	10.	34.94	8.6	7.5	35.96	3.	320. mg Calcium 540. mg Phosphorus 14. mg Iron	.22 mg B_1 .78 mg B_2 3.3 mg Niacin
BARLEY HULLED 1 c=203 gm	361	11.5	12.8	2.1	1.6	70.	2.	75. mg Calcium 373. mg Phosphorus 5. mg Iron 485. mg Potassium 171. mg Magnesium 143. mg Sulphur	.65 mg B_1 .12 mg B_2 3.1 mg Niacin
BUCKWHEAT FLOUR—DARK 1 c=98 gm	347	12.	11.7	2.5	1.6	70.4	1.8	33. mg Calcium 347. mg Phosphorus 2.8 mg Iron	.58 mg B_1 .15 mg B_2 2.9 mg Niacin
CAROB POWDER (St. John's Bread) 1 tsp=2 gm	351	10.	7.75	1.9	5.05	72.85	2.45	210. mg Calcium 120. mg Phosphorus 5. mg Iron 950. mg Potassium 80. mg Magnesium 10. mg Silicon	50. I.U. A .033 mg B_1 .053 mg B_2 2.53 mg Niacin
CAROB CANDY	130 per ¼ oz. bar								
CORNMEAL YELLOW—100% 1 c=118 gm	365	12.	9.1	3.7	2.	71.9	1.3	18. mg Calcium 276. mg Phosphorus 2.7 mg Iron 121. mg Magnesium .68 mg Manganese	510. I.U. A .17 mg B_1 2.1 mg Niacin 1.7 mg E 37. mg Choline
CORNMEAL WHITE—100% 1 c=118 gm	365	12.	9.1	3.7	2.	71.9	1.3	18. mg Calcium 248. mg Phosphorus 2.7 mg Iron 121. mg Magnesium .68 mg Manganese	.41 mg B_1 .12 mg B_2 1.7 mg Niacin 45. mg Inositol 37. mg Choline
POPCORN YELLOW Popped 1 c=14 gm	362	9.8	11.9	4.7	2.1	70.	1.5	10. mg Calcium 264. mg Phosphorus 2.5 mg Iron	.39 mg B_1 .11 mg B_2 2.1 mg Niacin
HOMINY GRITS 1 c=160 gm	362	12.	8.7	.8	.4	77.7	.4	4. mg Calcium 73. mg Phosphorus 1. mg Iron	.13 mg B_1 .04 mg B_2 1.2 mg Niacin
FLAXSEED WHOLE ½ c=83 gm	526	10	23.	36.7	4.9	21.95	3.45	260. mg Calcium 640. mg Phosphorus 11. mg Iron	.08 mg B_1 .13 mg B_2 5.5 mg Niacin
GARBANZO BEANS 1 c=210 gm	359	10.6	20.8	4.7	5.3	55.6	3.	92. mg Calcium 375. mg Phosphorus 7.1 mg Iron	Trace A .55 mg B_1 .17 mg B_2 1.5 mg Niacin 2. mg C
LENTILS ½ c=100 gm	337	11.2	25.	1.	3.7	55.8	3.3	59. mg Calcium 423. mg Phosphorus 7.4 mg Iron	570. I.U. A .56 mg B_1 .24 mg B_2 2.2 mg Niacin 5. mg C
MILLET WHOLE Hulled* ½ c=104 gm	334 327*	11.5 11.8*	9 9.9*	3.8 2.9*	3.5 3.2*	70.25 69.7*	1.95 2.5*	(whole) 80. mg Calcium 240. mg Phosphorus 27. mg Iron	(Whole) .12 mg B_1 .89 mg B_2 7.1 mg Niacin
MUFFIN MIX EL MOLINO ½ c=62 gm	351	10.	14.38	3.2	2.55	64.02	5.85	100. mg Calcium 900. mg Phosphorus 10. mg Iron	.14 mg B_1 .54 mg B_2 10.5 mg Niacin

APPROXIMATE COMPOSITION OF FOODS, 100 grams, Edible Portion

FOOD AND DESCRIPTION (Dry)	CALORIES per 100 gm	WATER gm	PROTEIN gm	FAT gm	FIBER gm	CARBO-HYDRATES gm	ASH gm	MINERALS per 100 grams	PRINCIPAL VITAMINS per 100 grams
MUNG BEAN SPROUTS — RAW 1 c=90 gm	23	92.4	2.9	.2	.7	3.4	.4	29. mg Calcium 59. mg Phosphorus .8 mg Iron	10. I.U. A .07 mg B_1 .09 mg B_2 .5 mg Niacin 15. mg C
OATS WHOLE GROATS ½ c=86 gm	390	8.3	14.2	7.4	1.2	67.	1.9	53. mg Calcium 405. mg Phosphorus 4.5 mg Iron 145. mg Magnesium 4.95 mg Manganese .5 mg Copper .17 mg Fluorine 5. mg Zinc	.6 mg B_1 .14 mg B_2 1. mg Niacin 150. mg Choline
OATS — ROLLED dry: ⅓ c=⅔ c cooked cooked: ⅔ c=136 gm	390	8.3	14.2	7.4	1.2	67.	1.9	53. mg Calcium 405. mg Phosphorus 4.5 mg Iron 145. mg Magnesium 4.95 mg Manganese .5 mg Copper .17 mg Fluorine 5. mg Zinc	.6 mg B_1 .14 mg B_2 1. mg Niacin 150. mg Choline
PEAS GREEN SPLIT ½ c=100 gm	344	10.	24.5	1.	1.2	60.5	2.8	33. mg Calcium 268. mg Phosphorus 5.1 mg Iron 1.99 mg Manganese 880. mg Potassium	370. I.U. A .87 mg B_1 .28 mg B_2 3.1 mg Niacin 2. mg C .3 mg B_6 330. mg Inositol 18. mg Biotin .02 mg Folic Acid 260. mg Choline
POTATO FLOUR (with peel) ½ c=92 gm	357	7.	7.1	.7	2.2	80.	3.	25. mg Calcium 88. mg Phosphorus 4. mg Iron	40. I.U. A .30 mg B_1 .11 mg B_2 4.5 mg Niacin 23. mg C
RYE — WHOLE (sifted flour) ½ c=40 gm	321	11.	12.1	1.7	2.	71.4	1.8	38. mg Calcium 376. mg Phosphorus 3.7 mg Iron 3.07 mg Manganese	.43 mg B_1 .22 mg B_2 1.6 mg Niacin
RICE — WHOLE BROWN (unpolished) ½ c=104 gm	360	12.	7.5	1.7	.6	77.4	1.1	39. mg Calcium 303. mg Phosphorus 2. mg Iron .36 mg Copper	.32 mg B_1 .05 mg B_2 4.6 mg Niacin 2.4 mg E
RICE BRAN ½ c=51 gm	364	9.1	12.5	13.5	12.	39.4	13.5	135. mg Calcium 1930. mg Phosphorus 20. mg Iron 1420. mg Potassium	2.73 mg B_1 .27 mg B_2 33.2 mg Niacin 3.21 mg B_6 7.3 mg Choline 10. mg E
RICE POLISH ½ c=57 gm	392	10.2	12.8	13.2	2.8	51.4	9.6	110. mg Calcium 1460. mg Phosphorus 659. mg Magnesium 660. mg Potassium 168. mg Sulphur 134. mg Chlorine	2.1 mg B_1 .13 mg B_2 36.8 mg Niacin 3.08 mg B_6 9.25 mg Choline 9.8 mg E
SESAME SEED HULLED ½ c=77 gm	582	5.5	18.2	53.4	2.4	15.2	5.3	110. mg Calcium 592. mg Phosphorus 2.4 mg Iron	.18 mg B_1 .13 mg B_2 5.4 mg Niacin
SEVEN GRAIN CEREAL (El Molino) ½ c=80 gm	382	10.	16.5	5.95	2.15	63.2	2.2	210. mg Calcium 445. mg Phosphorus 8. mg Iron	.13 mg B_1 .48 mg B_2 8.5 mg Niacin
SOYBEANS WHOLE ½ c=105 gm	331	9.	40.	18.	3.5	25.9	4.6	227. mg Calcium 586. mg Phosphorus 8. mg Iron 1700. mg Potassium 380. mg Sodium 20. mg Chlorine	140. I.U. A 1.07 mg B_1 .31 mg B_2 2.3 mg Niacin Trace C 320. mg Choline 1.18 mg B_6 .08 mg Biotin 229. mg Inositol

APPROXIMATE COMPOSITION OF FOODS, 100 grams, Edible Portion

FOOD AND DESCRIPTION (Dry)	CALORIES per 100 gm	WATER gm	PROTEIN gm	FAT gm	FIBER gm	CARBO-HYDRATES gm	ASH gm	MINERALS per 100 grams	PRINCIPAL VITAMINS per 100 grams
SOYA FLOUR (hulled) ½ c=56 gm	480	5.	41.	22.5	2.3	24.7	4.5	280. mg Calcium 600. mg Phosphorus 12. mg Iron 1670. mg Potassium 280. mg Magnesium 5.8 mg Manganese 270. mg Sulphur 280. mg Sodium 400. mg Silicon 1. mg Copper 2. mg Zinc 15. mg Chlorine .5 mg Iodine	140. I.U. A .5 mg B_1 .32 mg B_2 1.2 mg B_6 4.9 mg Niacin .059 mg Biotin 1.1 mg Pantothenic Acid 225. mg Choline 175. mg Inositol
(Lecithin: 2.2, Starch: 1.5, Alkalinity: 24.)									
SOYBEAN SPROUTS 1 c=107 gm	46	86.3	6.2	1.4	.8	4.5	.8	48. mg Calcium 67. mg Phosphorus 1. mg Iron	180. I.U. A .23 mg B_1 .20 mg B_2 .8 mg Niacin 13. mg C 1.56 mg B_6 .15 mg Biotin .336 mg Inositol
SUNFLOWER SEEDS Hulled ½ c=76 gm	602	10.	26.31	49.5	2	8.24	3.95	150. mg Calcium 880. mg Phosphorus 17. mg Iron	.13 mg B_1 1.71 mg B_2 6.8 mg Niacin
WHEAT RED CEREAL ½ c=107 gm Whole (Hard Northern Spring)	330	13	14.	2.2	2.3	66.8	1.7	36. mg Calcium 383. mg Phosphorus 3.1 mg Iron 370. mg Potassium 165. mg Magnesium 4.59 mg Manganese .72 mg Copper 8. mg Zinc .1 mg Fluorine	.57 mg B_1 .12 mg B_2 4.3 mg Niacin .21 mg B_6 170. mg Inositol 5. mg Biotin .19 mg Folic Acid 90. mg Choline
WHEAT BRAN FLAKES (from hard, red wheat) ½ c=28 gm	354	10.1	16.6	3.7	10.3	53.2	6.1	77. mg Calcium 1336. mg Phosphorus 16.7 mg Iron 1. mg Copper 14. mg Zinc	140. I.U. A .52 mg B_1 .35 mg B_2 3.2 mg Niacin
WHEAT GERM FLAKES (full fat) 1 Tbs=8 gm	361	11	25.2	10.	2.5	47.	4.3	84. mg Calcium 1096. mg Phosphorus 8.1 mg Iron .3 mg Fluorine	2.05 mg B_1 .8 mg B_2 4.6 mg Niacin 26. mg E .6 mg B_6 690. mg Inositol .3 mg Folic Acid 400. mg Choline
WHEAT GERM AND MIDDLINGS ("Scalp of Sizings", "Caltech") ½ c=55 gm	361	11.6	15.4	3.48	2.41	64.87	2.24	61. mg Calcium 583. mg Phosphorus 11. mg Iron 486. mg Potassium	1.5 mg B_1 .4 mg B_2 8.26 mg Niacin 10. mg E
WHEAT GLUTEN FLOUR ⅓ c=45 gm	355	8.62	41.6	1.76	3.75	43.6	.67		
"UNBLEACHED" WHITE FLOUR (Hard Wheat) sifted 1 c=112 gm	365	12.	11.8	1.1	.3	74.4	.4	16. mg Calcium 95. mg Phosphorus .9 mg Iron	.08 mg B_1 .06 mg B_2 1. mg Niacin

Household measurements (in terms of cups and spoons) are shown in grams to enable you, thru simple ratio, to determine any specific data desired in terms of cups or spoons.

For easier use, we have avoided cluttering our tables with reference numbers. We shall be glad to give the source of any figures of interest to our readers.

Many vitamins and minerals are contained in these products which we have not listed. As additional information is obtained it will be made available.

The Settlement Cookbook

1927

CHAPTER XLII

Preserving *and* Pickling of Fruits

Fruits are preserved into marmalades, jams and conserves, by cooking with from ¾ to their whole weight in sugar. They retain their best flavor and bright color if cooked rapidly over a hot fire.

Jams made with pectin, page 540, require less boiling and retain their color and flavor. They require extra sugar, but produce more jam or jelly.

No. 1 STRAWBERRY PRESERVES

Select large, sound strawberries. Pick and wash them carefully. Place in preserving kettle alternately 1 pound of berries and from ¾ to 1 pound of sugar. Let stand over night. Place on stove, let come to a boil, cook steadily for 15 minutes or until the fruit is clear. Cover and let stand over night. Put in jelly glasses or jars.

No. 2 STRAWBERRY PRESERVES

3 qts. strawberries, 5 cups sugar,
2 cups water or berry juice.

Pick over, wash and stem fine, large strawberries. Then weigh 2 lbs. Boil sugar and water or the berry juice, to a thick syrup, then skim. Add berries, cover, and bring slowly to a boil. Remove cover, let boil rapidly for 15 minutes. Then cover and let stand until cold. Remove cover, let stand over night. Then pour in sterilized jelly glasses, cover with paraffine.

For Berry Juice, crush, heat and strain the imperfect berries.

Raspberries or Blackberries may be preserved the same way.

SUNSHINE STRAWBERRIES

Use equal weights of sugar and strawberries. Put the strawberries in the preserving kettle in layers, sprinkling sugar over each layer, not more than 2 inches deep. Place on stove and heat slowly to the boiling point. Skim carefully. Boil rapidly for 10 minutes. Pour on platters, cover with glass. Let stand in sunshine 8 to 12 hours. Pour into jars or tumblers.

SUNSHINE CURRANTS OR CHERRIES

Select large, firm red or white fruit, remove the stems, and proceed as for strawberries. Stone the cherries before weighing.

CHERRY OR RASPBERRY PRESERVES

5 lbs. cherries or raspberries, 5 lbs. sugar.

Wash raspberries carefully that they do not mash; or wash, pick over and stone the cherries. Place in preserving kettle, alternate layers of sugar and fruit; let stand over night. Bring slowly to the boiling point and boil rapidly until thick and clear. Put away in glasses or jars.

CHERRY, CURRANTS AND RASPBERRY CONSERVE

1 quart cherries, 1 pint raspberries,
1 quart large currants, 1 large orange,
sugar.

Wash and pick over the fruit, stone cherries. Cut the orange in thin slices. Weigh and add an equal amount of sugar. Let come to a boil slowly, then boil rapidly until thick. Turn into jelly glasses.

BAKED CRABAPPLE PRESERVES

¾ peck crabapples, 1-gallon stone jars,
4 lbs. sugar, 1 tablespoon water.

Wash, wipe and remove the blossom ends of perfect, large, red crabapples. Pour water in bottom of a covered dish or jar, then place in alternate layers of apples and sugar, not too full, (with sugar on top). Cover. Bake 2 or 3 hours in a slow oven, 250° F., basting 3 or 4 times with the hot syrup. Place in sterilized glasses, and seal.

Baked Sickel Pears—May be prepared the same way. Flavor if desired, with ginger or lemon juice.

Baked Quinces—Quinces may be wiped, cored, and quartered; sugar filled in the cavities, and baked same as crabapples, in a slow oven, 250° F., 3 or more hours until clear and glassy.

BAKED CRANBERRIES OR CHERRY PRESERVES

4 quarts cranberries or sour cherries, 4 quarts sugar,
1-gallon stone jars.

Pick over, wash and drain large, perfect cranberries; or stem and then stone large cherries (so they remain whole). Place a tablespoon hot water in a covered casserole, dish or jar, not too full, then alternately in layers cranberries or cherries and sugar (with sugar on top), cover closely. Bake in a slow oven 2 hours, 250° F., basting with the syrup several times. Place in hot jars and seal.

WATERMELON RIND PRESERVES

Peel the rind of a watermelon that is not too ripe, cut or chop into ½ inch cubes or strips, leaving as much of the firm, red pulp on the rind as possible.

To 4 cups of diced, (or sliced) melon take 3 cups of sugar, 3 lemons, sliced fine, and seeded. Let boil slowly about 2 hours until the rind is clear and the juice is thick. Place in airtight jars. Or, take 2 oranges and only 1 lemon for variety.

Or, when nearly done, add a small can of grated pineapple and cook 15 minutes longer.

QUINCE AND SWEET APPLE PRESERVES

1 peck quinces, ½ peck sweet apples, (Tolman),
½ peck pears, Sugar.

Wash quinces and apples, then peel, core and cut in rounds, peel pears and cut in quarters. Cover cores and peels with cold water, boil thoroughly and strain. Boil the quince rounds in cold water until they can be pierced with a silver fork, remove carefully to platter. Weigh the fruit, and for each pound of fruit allow ¾ pound of sugar, add to the strained liquid and let boil until a clear syrup. Add the fruit, boil slowly and steadily for 3 or 4 hours until the fruit is clear and a deep red color. Pour into crocks or jars and cover.

GINGER PEARS

8 lbs. pears, ¼ lb. Canton ginger,
4 lbs. sugar, 4 lemons.

Wipe pears, quarter, core and remove the stems and cut into small slices. Add sugar, the ginger, cut fine, and the juice of the lemons. Cut the lemon rinds into long, thin strips; mix all together and let stand over night. Place in preserving kettle, on stove and let cook slowly for 3 hours, or until thick and clear. Put in stone jar, well covered, or in glass cans.

GINGER APPLES

1 qt. sour apples, diced, 1 lemon,
2 cups brown sugar, 2 cups water,
6 pieces ginger root.

Wipe, pare, quarter, core and cut the apples into small squares Grate the rind of the lemon. Boil water, sugar and lemon juice 12 minutes or until clear, add the rest of the ingredients and cook slowly 2 or more hours until thick and brown.

Will keep for several weeks, or longer if filled while hot in air-tight cans.

BLUEBERRY OR RASPBERRY AND APPLE BUTTER

1 qt. blueberries, or raspberries, 1 qt. apple pulp,
3 lbs. sugar.

Use tart apples. Remove stems, cut in quarters. Add enough water to cover and cook until soft. Put through strainer. Measure apple pulp, and blueberries or raspberries and take an equal amount of sugar; cook until clear and thick, then place in clean, hot jars and seal.

BLUEBERRY AND CRABAPPLE JAM

3 qts. crabapples, chopped, 1 qt. blueberries,
6 lbs. sugar.

Cut crabapples in quarters, remove cores but do not pare, put through food chopper, measure, add enough water to almost cover apples, cook 10 minutes, add berries and sugar, let cook until clear; pour into clean, hot glasses; let cool, cover with hot paraffine.

APPLE BUTTER

1 peck apples, 3 lbs. sugar,
4 quarts water, Cinnamon,
2 quarts cider, Cloves.

Wash the apples and cut in small pieces. Add the water, boil until the apples are soft, and rub through a sieve. Boil cider down ½, add hot apple pulp, sugar and cook until nearly done, stirring constantly. Add the ground spices and cook until thick enough to spread without running. Pour into jars and seal with paraffine.

APRICOT JAM

1 lb. dried apricots, ¾ cup apricot water,
1½ cups sugar, 1 orange.

Wash the apricots, soak over night, in cold water to cover. Slice the orange fine and cut each slice into small pieces and if desired, add 1 cup of seedless raisins, mix well with sugar and water and cook slowly until thick—about 1 hour. Turn into jelly glasses and cover well.

GROUND CHERRIES

Remove husks from ground cherries. Make a syrup of 1½ cups sugar, 3 cups water and juice of 2 lemons; boil 5 minutes; add enough cherries to come to top of syrup. Boil slowly until cherries are tender and clear, can and seal in sterilized jars as other fruit.

Or, in place of the lemon, add ⅓ as many sliced tart apples and cook until apples and ground cherries are thick and clear.

GRAPE PRESERVES

4 lbs. grapes, 4 lbs. sugar.

Pick over, wash, drain, and remove stems from grapes. Press the pulps from the skins. Heat pulp to boiling point and cook slowly until seeds are free. Rub through fine sieve. Return to kettle, add skins and an equal measure of sugar; cook slowly 30 minutes, stirring occasionally to prevent burning. Put in a rs or tumblers.

GREEN TOMATO PRESERVES

1 quart sliced green tomatoes, 1 lemon, grated yellow rind, juice and pulp,
1 quart sugar, 1 stick cinnamon.

Place in kettle, let stand several hours to draw juice. Cook until tomatoes are thick and clear.

TOMATO PRESERVES

1 lb. yellow pear tomatoes, or, the red ones, sliced, 2 oz. Canton ginger, or a few pieces of ginger root,
1 lb. sugar, 1 lemon, grated rind and juice.

Scald the tomatoes and peel. Cover with the sugar, and let stand over night. Drain syrup into preserving kettle and boil until clear and quite thick and skim. Add ginger, grated yellow rind of lemon, cut in half, scooping out juice and pulp, and add to tomatoes. Cook until the fruit is clear. Pour into jars or crocks.

PLUM JAM

Wash and pick over plums. Remove the stones. If Damsons are used, cover stones with water and cook separately. Strain and add juice to plum pulp. Measure pulp and to each cup add from ¾ to 1 cup of sugar, depending on sweetness of fruit. Place in preserving kettle and boil slowly, stirring constantly to prevent burning. When clear and thick, put in jelly glasses or jars.

GRAPE CONSERVE

8 lbs. Concord grapes, 3 or 4 oranges,
1 lb. seeded raisins or figs, 2 lemons,
Sugar.

Pick over, wash, drain and remove stems from grapes. Put in preserving kettle, add only a little water, let simmer, until the seeds are free, then press through sieve, discarding skins and seeds. Add oranges and lemons cut fine; to 1 lb. fruit, add 1 lb. sugar. Boil until thick. Fill jelly glasses. Cool and seal.

CHERRY CONSERVE

5 lbs. ripe cherries, 1½ lbs. seedless raisins,
5 lbs. sugar, 4 oranges,
2 lemons.

Wash, stem and pit the cherries. Squeeze out the juice of the oranges and lemons. Wash raisins. Mix all together and let stand over night. Then boil slowly and steadily for several hours, or, until thick and clear. Pour in cans and seal.

GOOSEBERRY CONSERVE

3 lbs. gooseberries, 1 lb. seeded raisins,
3 lbs. sugar, 3 large oranges.

Grate the rind of the oranges, remove the skin and use grated rind and juice. Mix all together and cook slowly until thick. Seal hot.

RHUBARB CONSERVE

To 3 cups of pieplant cut, add 3 cups of sugar and the juice of 3 oranges and 1 lemon. Cook 30 minutes. Then add the grated rind of oranges and lemon and ½ lb. of chopped almonds. Cook 5 minutes longer.

RHUBARB AND FIG PRESERVE

2 lbs. rhubarb, 2 lemons, juice and rind,
½ lb. figs, 2½ lbs. sugar.

Wash figs and rhubarb and cut in small pieces. Grate the lemon rind, add sugar and lemon juice and stir often until juice is formed. Place in preserving kettle, cook gently for 30 minutes, add the grated lemon rind, boil 15 minutes longer until thick and clear. Place in jelly glasses and pour paraffine over top.

PLUM CONSERVE

3 lbs. blue plums or prunes, Juice of 2 lemons,
1 lb. seeded raisins, 3 lbs. sugar,
3 oranges, cut in small pieces, 1 lb. English walnuts, meats.

Wash the plums, remove the stones and cut them into small pieces. Mix with the rest. Place in preserving kettle, on stove, let come slowly to the boiling point and cook steadily until the fruit is clear and thick. Put in jelly glasses or jars.

PEACH CONSERVE

3 lbs. peaches, 1 orange,
1 small can pineapple, Sugar.

Pare peaches, add 2 cups of water and cook until soft. Mash or rub through colander, add pineapple cut in small pieces, and the orange, and cook until slightly thickened. Add ¾ as much sugar as fruit, and cook until it is as thick as marmalade. If fresh pineapple is used, it should be cooked with the peaches.

CHERRY AND PINEAPPLE CONSERVE

1 qt. sour red cherries, 1 pt. tart apples, diced,
1 cup grated pineapple, 4 cups sugar.

Mix all ingredients and cook slowly until mixture is thick and clear. Turn into jelly glasses. When cold cover with hot paraffine.

PEAR CONSERVE

1 pk. pears, 1½ lbs. English walnut meats,
4 lbs. sugar,
1 lb. raisins, seeded, 3 lemons, juice,
2 oranges, juice.

Pare, core and slice the pears in large pieces, crosswise; add sugar and let stand over night. Drain off the liquid and let boil to a syrup, about 12 minutes, then add pears and the rest of the ingredients, breaking the walnuts into pieces, about the size of the raisins. Let cook slowly 1 hour until thick and clear. Place in jars. Cover well.

PEAR AND APPLE CONSERVE

9 hard pears, ½ lb. Canton ginger,
6 tart apples, ½ pint water,
1½ lemons, Sugar.

Pare, quarter and core the pears. Pare apples, core and cut crosswise in ½ inch slices. Grate the rind of the lemons and add the juice to the water. Cut ginger in small pieces. For every pound of fruit allow one pound of sugar. Boil sugar and water to a syrup, add the rest of the ingredients and boil ¾ hour or until thick and clear. Place in cans or glasses and cover well.

QUINCE CONSERVE

4 medium quinces, ¼ lb. prunes, stoned,
3 large tart apples, ¼ lb. dried figs, cut,
1 cup seeded raisins, 1 qt. water,
½ cup maraschino cherries, 4 cups sugar.

Peel quinces and cut in thin slices. Cut cherries fine, mix all ingredients and cook slowly until quinces are tender, then add sugar, bring slowly to the boiling point, let cook steadily until thick and clear. Pour while scalding hot in sterilized jars and seal.

ORANGE AND PEACH MARMALADE

3 oranges, 9 peaches,
Sugar.

Cut oranges in eighths, slice thin, simmer until tender.
Skin peaches, slice, and add to oranges. Measure, and to 4 cups fruit add 3 cups sugar, and simmer until thick and clear. Put in glasses, cover with paraffine.

GOLDEN CHIP

6 lbs. pumpkin, 4 lemons,
6 cups sugar, 2 oz. green ginger root,
1 quart water.

Cut pumpkin into balls with French cutter or into cubes, add ginger root and lemons in small, very thin slices, and put into sauce pan. Add water and let stand over night. Cook very slowly until tender, add sugar, cook until it will jell, and is a light amber color. Put in jelly glasses.

BEET PRESERVES

4 lbs. beets, 3 lemons,
3 lbs. sugar, ¼ lb. almonds,
2 oz. green ginger root.

Wash and peel young beets, slice very thin or put through meat grinder. Place in preserving kettle, cover with water and let cook slowly until tender. Add sugar, ginger root, blanched and sliced fine, the lemon juice and grated rind. Cook gently until thick and clear, about 1 hour. When nearly done, add almonds (blanched) and put through grinder. The almonds and the ginger may be omitted and dried ginger root may be used in place of the green. Put in jelly glasses and cover with paraffine.

CARROT MARMALADE

3 lbs. raw grated carrots, 6 lemons,
3 lbs. sugar, ¾ lb. grated almonds.

Take young carrots, wash, scrape and put through meat grinder. Cover with water and cook until tender. Press through a strainer to make a smooth pulp. Add sugar, the grated yellow rind of lemons, and the juice. Place in preserving kettle, let cook gently, about ½ hour, or until thick and clear. When nearly done add almonds, blanched and put through grinder. Put in glasses, and when cool, cover with paraffine.

RADISH PRESERVES (Russian Style)

1 qt. radishes, 1 qt. strained honey,
1 oz. ginger root, Almonds cut in thin slices.

Cut radishes (black) in thin slices ¼ by 1 inch. Cook in boiling water 3 or 4 minutes. Drain and dry between towels. Add honey and ginger and cook until syrup drops heavy from spoon. Put in jelly glasses. Serve mixed with almonds.

ORANGE MARMALADE

6 large oranges, 3 qts. cold water,
2 tablespoons lemon juice, 4 cups sugar.

Cut oranges in half, scoop out juice and pulp. Boil rind in cold water to cover, until tender; drain, cool, remove all the white part. Cut yellow into strips, add juice, pulp, sugar, and water; boil slowly 2 hours or until thick. Turn into jelly glasses.

GRAPEFRUIT MARMALADE

2 grapefruit, 2 lemons,
2 oranges, Sugar.

Wash fruit. Remove core and seeds of grapefruit. Remove thin, yellow outside rind, and cut ½ of it in fine strips. Remove the thick white peel, but do not use. Mix shaved rind with the cut up fruit pulp. Put into preserving kettle with 3 times as much water and let stand over night. Put on stove, let come to boiling point and boil for 2 minutes. Repeat this for 2 days. The third day measure, add an equal amount of sugar and boil 1 hour or until thick. Turn into jelly glasses.

PINEAPPLE AND GRAPEFRUIT MARMALADE

1 lemon, 1 pineapple,
1 grapefruit, Sugar.

Pare and shred the pineapple. Cut grapefruit and lemon in quarters and then in thin slices. Measure fruit and cover with water, 3 pints water to 1 pint of the fruit. Set aside until next day. Let boil 3 or more hours and until rind is very tender. Set aside until next day. Measure and add an equal amount of sugar. Let boil until a drop jells on a cold plate.

PINEAPPLE AND PEAR PRESERVES

1 lb. pears, 1½ cups sugar,
1 can sliced pineapple, ¾ cup boiling water.

Dissolve sugar in water, let heat to boiling point. Cut pears in halves lengthwise, remove cores and skin and add to hot syrup. Let cook until pears are tender. Cut pineapple slices in quarters, add to syrup also, and let cook until fruit is clear. Put in sterilized jars and seal.

STRAWBERRY AND PINEAPPLE JAM

Run pared and cored pineapple through a food chopper. Take equal parts of strawberries and pineapple. To every 5 cups of fruit add 4 cups sugar. Let stand several hours. Put in preserving kettle, let cook gently until clear and thick. Put into jelly glasses. Cover and set in a cool, dry place.

RASPBERRY OR STRAWBERRY AND RHUBARB JAM

4 cups sugar, 3 cups cooked rhubarb,
3 cups strawberries or raspberries.

If raspberries are used, pick over, wash, mash and cook quickly at first until soft. Strain, and set aside juice.

Use tender red rhubarb, trim off hard ends, wash, and without skinning, cut into small pieces. Mix fruit and sugar, let stand several hours. Put in preserving kettle, let cook gently until clear and thick. Place in jelly glasses.

PINEAPPLE AND APRICOT MARMALADE

No. 1

1 large pineapple, or 1 can, 6 doz. fresh apricots,
3 cups sugar to 4 cups fruit.

Pare, core and cut pineapple in cubes, cut apricots in halves, remove stones and place with the pineapple in preserving kettle. Measure, and to 4 cups fruit, add 3 cups sugar. Heat slowly to the boiling point and let cook gently until thick and clear. Place in glasses, cover with paraffine.

No. 2

½ can pineapple, 3 cups sugar to 4 cups
½ lb. dried apricots, fruit.

Soak the apricots over night, add pineapple. Cook the fruit until tender (about 1 hour) and add the sugar. Let cook gently until clear. Pour into jelly glasses and when cool cover with paraffine.

CRANBERRIES WITH SALT

1 quart cranberries, ½ level teaspoon salt,
2 cups water, 1 cup sugar.

Bring water and salt together to the boiling point. Pick over, wash cranberries and add to boiling water. Let cook rapidly 5 minutes, or until the skins burst. Cool slightly, add sugar, bring to boiling point and cook slowly 5 minutes more.

Or, boil the berries with the salt and water until soft, and when nearly cool stir in the sugar. Put in jelly glasses and cover with paraffine.

CRANBERRY CONSERVE

1 qt. cranberries, ½ lb. walnuts,
1½ cups water, 1 orange,
¾ lb. raisins, 1½ lbs. sugar.

Boil cranberries with ½ the water until they burst. Strain, add remaining ingredients, (raisins, walnuts and oranges cut in pieces), boil 25 minutes and pour in a wet mould and chill or in jelly glasses, cover and keep for future use.

WHOLE PRESERVED KUMQUATS

1 qt. kumquats, 2½ cups sugar,
2 cups water.

Wash kumquats thoroughly, put on in cold water, and boil up once, then drain. Make a syrup of sugar and water, add kumquats, and cook very gently until clear, about 2 hours. Put the fruit in jars and pour over syrup, which should be boiled down if not very thick. This amount will fill 4 pint jars.

PICKLED FRUIT

PICKLED APPLES

9 lbs. apples, 1 pint water,
4 lbs. sugar, 1 quart vinegar,
½ cup broken cinnamon and cloves mixed.

Select "Pound Sweets" or large Crabapples. Pare the sweet apple, leave crabs whole, with stems.

Place fruit in crock alternately with layers of sugar and pour vinegar and sugar over and let stand over night covered. Drain and to the liquid add the spices, tied in a bag, soft heads of cloves removed. Heat slowly to the boiling point and when clear, add the apples; boil until tender but not soft. Place apples in heated glass cans, using perforated skimmer and place cover on can. Let syrup boil down a little and lifting covers, pour the boiling syrup over the fruit and seal at once.

PICKLED CRABAPPLES

6 lbs. crabapples 1 tablespoon cloves
1 qt. cider vinegar 2 sticks cinnamon
2 cups sugar 1 tablespoon ginger

Wash crabapples, let steam until soft. Place in preserving kettle with vinegar, sugar and spices tied in a bag. Bring slowly to boiling point, cook gently about 20 minutes. Pour in jars and seal.

PICKLED PEARS

12 lbs. pears, peeled, 1 pt. vinegar,
4 lbs. sugar, ½ cup broken cinnamon and
1 cup water, cloves, mixed.

Place pears, in a crock alternately with layers of sugar. If large pears are used, core and quarter them. Cover with the water and vinegar. Let stand covered over night. Drain and to the liquid add the spices tied in a bag, soft heads of cloves removed. Heat slowly to the boiling point, and when clear, add the pears, boil until tender but not soft. Place in hot sterilized jars, using perforated skimmer, and place cover on can. When fruit is all cooked and in the can, lift covers and pour the boiling syrup over the fruit and seal at once.

PICKLED PEACHES

6 lbs. (½ peck) peaches, 2 tablespoons cloves, heads
3 lbs. sugar, removed,
1 pint cider vinegar, 2 sticks cinnamon, broken in
1 cup of water, pieces.

Pare large clingstone peaches and weigh. Boil sugar, vinegar and spices, tied in a bag, about 12 minutes or until clear. Add peaches, only enough for one can at a time, and cook, testing with a straw, until thoroughly heated. Lift out of kettle with perforated skimmer, place in jars and cover to keep hot. Continue the same way until all the peaches are cooked. Cook syrup down a little, pour boiling hot over the peaches. Screw down covers immediately and seal air-tight.

PICKLED PLUMS

6 lbs. plums, 1 tablespoon cinnamon,
3½ lbs. sugar, ½ tablespoon allspice,
1 pt. vinegar, ½ tablespoon cloves.

Remove stones from plums or prick with fork. Boil vinegar, sugar and spices, then add plums and boil slowly 30 minutes. Place in jars and seal.

SWEET PICKLED WATERMELON

2 lbs. Watermelon rind, 2 qts. vinegar,
1 cup salt to 4 qts. water, 4 cups sugar,
¼ cup mixed pickle spices.

Pare rind, remove all red meat and cut into small strips or squares. Soak in salt water over night. Next morning soak in fresh water about 2 hours, drain. Boil vinegar, sugar and spices, tied in a bag, until clear, about 12 minutes. Add the watermelon rind and boil until tender, but not soft. Test with a straw. Remove rind to jar, with perforated skimmer, boil syrup down a little and pour hot in jars over the cooked rind. Cover air-tight and keep in a cool place.

PICKLED CHERRIES

2 qts. sour cherries, 4 lbs. sugar,
Vinegar.

Pit the cherries and put into a large stone jar, cover with vinegar and let stand for 24 hours (stir it up a few times.) Then drain off the vinegar. Measure the same amount of sugar as cherries, and alternate in layers, sugar on top. Stir this each day for 3 days, or until all the sugar is dissolved. Then bottle.

SPICED CHERRIES

6 qts. cherries, pitted, ½ tablespoon ground allspice,
3½ lbs. white sugar, ½ tablespoon ground cloves,
1 pt. cider vinegar, ½ nutmeg, grated.
1 tablespoon ground cinnamon,

Mix sugar, vinegar and spices, until dissolved and pour over the cherries. Stir well for 3 mornings and then can or bottle and seal.

Spiced Currants—Stem the currants and proceed same as for spiced cherries, using less spice.

SPICED GOOSEBERRIES

5 lbs. under ripe gooseberries, 1 tablespoon cinnamon,
4 lbs. sugar, ½ tablespoon allspice,
1 pt. vinegar, ½ tablespoon cloves.

Wash and stem the fruit. Bring vinegar, sugar and the spices (ground), to a boil. Add the berries and boil slowly 20 minutes. Place in glasses and cover well.

PICKLES, CATSUPS AND RELISHES

GENERAL RULES FOR PICKLES

Cucumbers for pickling must be fresh picked, not over 24 hours old. Dill is best, when seeds are full grown, but not so ripe that the seeds fall off the stalk. Use common salt, not table salt. Use pickling vinegar.

Pickles will spoil if not kept completely under the brine. About ½ their measure in brine will cover cucumbers. (½ gallon brine covers gallon cucumbers.) Mix salt with small amount of water, then add rest of the water. A salt brine that will just lift up an egg or a potato from the bottom of the crock is a 10% solution, or 1 cup salt to 9 cups water. A weak brine, ½ cup salt to 9 cups water (5%) or less, will cause quicker fermentation, but pickles kept in this brine will spoil in a few weeks, unless the scum that rises to top of jar is constantly skimmed off and the brine is clear.

It is best when all fermentation stops, when the pickles are done, to remove them to jars, cover them with their own brine, or add fresh cooled brine, and seal.

Pickles will shrivel if too much sugar or salt is added at one time or if vinegar is too strong. Pickles that are cured, salt pickles or dill pickles may be made into sweet, sour or mixed pickles and will not shrivel.

SUMMER DILL PICKLES

100 large cucumbers, 1 cup vinegar,
5 stalks dill, Grape or cherry leaves,
1 oz. black peppercorns, 1 cup salt,
Bay leaves, 4½ quarts water.

Soak cucumbers in cold water over night, or 12 hours. Drain and dry. Place in layers of 2 rows cucumbers, then 3 or 4 blossom ends of dill and a teaspoon of whole black pepper; repeat, covering top layer well with dill and adding some cherry or grape leaves. To 4½ quarts of water, take 1 cup of salt. Boil, and when cool, pour over the pickles to cover. Cover with cloth. Weight well with plate, to keep under brine. Let stand in warm place to ferment for a week. One cup of vinegar may now be added. Rinse off scum that arises on cloth every day in warm weather and once or twice a week when cooler.

Or when pickles are done, add the vinegar and pack in 2-qt. sterilized jars, add fresh dill, cover with brine and seal; pickles will keep hard all winter. Keep cool, in a dry place.

No. 1 WINTER DILL PICKLES

100 large cucumbers, 1 small horseradish root, diced,
1 large bunch dill, 1 cup salt,
10 quarts water, ¼ cup vinegar.

Soak large, thin cucumbers 4 inches or more in salt water over night. (1 cup salt to 4 qts. water.) Drain and wipe dry. Place in sterilized jars with layers of dill and small pieces of horseradish. Boil 4 quarts water, ½ cup salt and ¼ cup vinegar and pour boiling hot over the pickles, being careful not to crack the glasses. Put on rubber and seal in 2-quart air-tight jars. If brine should ooze out, within a week, do not disturb and when active fermentation stops, pour over enough fresh cooled brine to cover, and seal.

No. 2

In place of pouring the boiling hot brine over pickles make a brine by boiling 10 quarts of water, 1 quart of vinegar and 2 cups of salt; let cool and pour over pickles in jars and seal.

SMALL DILL PICKLES

Thin cucumbers, 3 to 4 inches, Horseradish root,
Small red peppers, 1 cup salt to 4 qt. (16 cups water),
Dill,

Scrub pickles and place them upright in sterilized jars. Between each layer, place a few blossom ends of dill, diced horseradish root and small pieces of red peppers. Add salt to water, pour over pickles to cover, and arrange stems of dill across top of jar to keep pickles under brine. Seal, add more salt water next day if necessary to cover. Watch for a week if brine has oozed out, add more fresh brine to fully cover, and seal.

ESTRAGON PICKLES

25 cucumbers (thin, long), 12 bay leaves (dried),
1 stalk dried estragon, 1 cup salt,
1 bunch of dill (6 stalks), 1 quart water,
1 horseradish root (diced), 2 quarts vinegar,
2 tablespoons white pepper corns, ½ lb. mustard seed.

Soak pickles in cold water 12 hours, or over night. Drain and wipe. Place over each layer of pickles 2 or 3 blossom ends of dill, 3 or 4 one-half inch pieces of estragon (stalks and leaves), a few small pieces of horseradish root, one tablespoon of whole white pepper and 3 or 4 dried laurel leaves. Make a brine of 2 quarts of vinegar, 1 quart water and 1 cup of salt, beat together until it foams, and pour over the pickles to cover. Cover the whole with a bag, made to fit the top of crock. Pour mustard seeds in bag and sew up. Cover with plate and stone, and keep in a cool, dry place. Must stand 5 or 6 weeks. Keep well.

EASY CUCUMBER PICKLES

Cucumbers, 1 cup salt,
2 quarts vinegar, 2 cups sugar,
1 quart water 1 cup ground mustard.

Soak small cucumbers in cold water to freshen. Mix dry ingredients, and add vinegar gradually to dissolve mustard. Pour mixture over as many cucumbers as it will cover. Add fresh cucumbers from day to day until crock is full. Then cover with plate and weight down. Ready for use in several weeks.

No. 1 SWEET PICKLES (WHOLE)

50 small cucumbers, 2 cups sugar,
3 cups vinegar, 1 bunch dill,
1 cup water, Mixed spices.

Soak cucumbers in salt water over night. (½ cup salt to 1 qt. water). Drain and dry. Boil vinegar, water and sugar 10 minutes or until clear, add cucumbers and let stand over low fire, until they lose their grass-green color. Place 1 teaspoon mixed

spices and a few dill blossoms in bottom of each jar, add pickles, cover with hot syrup, place dill on top and seal.

No. 2

100 small cucumbers,	Sugar and salt,
3 quarts water	½ teaspoon essence of cinnamon,
2 teaspoons powdered alum,	
Vinegar to cover,	½ teaspoon essence of cloves.

Wash cucumbers, put in salt water (1 cup salt to 9 cups water). Let stand 9 days. Stir twice each day. Drain, cover with clear, cold water, let stand several hours and drain. Let 3 quarts with the alum come to boiling point. Add cucumbers; when boiling, cover, and let boil 6 minutes. Drain. Cool perfectly in running cold water. Drain, place in stone jar, cover with vinegar, let stand one week. Pour off vinegar and measure. To each pint of vinegar add 1 cup of sugar. Boil 5 minutes. When cold, add essence of cinnamon and cloves and if desired small peppers. Place pickles in sterilized jars, pour over prepared vinegar to cover, and seal.

No. 3

5 pounds small cucumbers,	1 tablespoon mustard seed,
1 quart vinegar,	1 tablespoon cinnamon,
2 cups sugar,	1 teaspoon allspice,
Salt,	1 teaspoon cloves.

Soak cucumbers over night in 2 tablespoons salt to 1 quart water. Next morning heat brine, skim it and pour over the cucumbers. Let stand 2 days. Heat again, pour over cucumbers, let stand again 2 days. Pour the hot brine over and again the next 2 days, 5 times altogether. On the eighth day drain and throw away the brine. Place cucumbers in preserving kettle, add vinegar, sugar, a little salt and spices tied in a bag. Heat through, remove spices, put in clean, hot jars. Seal.

SWEET PICKLES (SLICED)

No. 1—In Inch Slices

25 large cucumbers,	1 pint vinegar,
2 qts. cherry leaves,	3 lbs. sugar,
3 tablespoons caraway seed,	¼ cup mixed spices.

Place large thin cucumbers (dill pickle size) in 2-gallon crock, alternately with cherry leaves and caraway seed, having cherry leaves at bottom of crock and on top.

Cover with salt water, ½ cup salt to 1 gallon of water. Let stand 14 days. Cover with weight to keep under brine. Drain, cut in inch pieces. Pack in quart jars. Invert jars to drain. Let stand 1 hour. Make a syrup, using 3 pounds sugar to every pint of vinegar. Add a small piece of alum if desired and ¼ cup mixed spices tied in a bag. Pour boiling hot over pickles, and seal.

No. 2—In Inch Slices

6 garlic cloves,	5 qts. vinegar,
50 dill pickles,	½ cup black peppers,
½ cup olive oil,	½ cup mixed spices,
10 lbs. sugar.	

Drain and dry left over dill pickles. Cut crosswise 1 inch pieces and put in stone crock. Mix the rest of the ingredients together, adding the spices tied in a bag, and boil 3 minutes. Pour in crock. Let stand 1 week, stirring every day. Then pour in jars and seal.

No. 3—Sliced Thin

50 cucumbers, 3 inches long.	1 cup best salad oil
½ cup salt	½ oz. mustard seed
2 medium onions	½ oz. celery seed
1 qt. vinegar	1 cup sugar

Slice cucumbers, without peeling, ¼ inch thick. Slice onions. Sprinkle with salt and let stand 12 hours, then drain. Add the rest of the ingredients, mix well. Set aside for a few hours. Pack in sterilized jars with liquid. Adjust rubbers, place covers on loosely. Put jars in warm water bath, let simmer 15 minutes. Seal.

No. 4—Sliced Thin

1 quart sliced cucumbers,	1 cup medium brown sugar,
1 medium onion, sliced,	1 teaspoon mustard seed,
¼ cup salt,	½ teaspoon celery seed,
2 qts. water,	1 tablespoon mixed spices,
1 pt. cider vinegar,	¼ teaspoon tumeric.

Use large, green cucumber, scrub well, cut off ends; but do not peel. Dissolve salt in water, pour over onions and cucumbers, let stand 3 hours and drain. Add mustard, sugar, and celery seed and the mixed spices, tied in a bag, to the vinegar and bring to boiling point. Add onions and cucumbers. Bring to boiling point again, add tumeric, stir and let cool. Seal when cold.

SLICED CUCUMBERS (Peeled)

6 large cucumbers	1 pt. vinegar
¼ cup button onions	1 cup water
1 tablespoon tiny red peppers	¼ cup sugar
2 tablespoons mustard seed	Oil

Take large salad cucumbers. Peel. Slice ¼ inch thick, let stand in ice chest over night or for several hours in salt water, ½ cup salt to 1 quart water. Strain. Put in sterilized pint jars, layers of pickles, a few tiny onions and small red peppers.

Boil sugar, vinegar and water, cool and pour over pickles, add ½ teaspoon mustard seed to each bottle, and olive oil to cover.

RIPE CUCUMBER PICKLES

12 large ripe cucumbers,	¼ cup mixed spices,
1 qt. small white onions,	Horseradish root,
1 bunch dill,	Vinegar,
1 tablespoon ground mustard.	

Peel, cut in halves cucumbers lengthwise, scrape out seeds and soft pulp with silver spoon. Cut in pieces as desired. Peel onions, sprinkle with salt and let stand. Place cucumbers in salt water, 1 cup salt to 8 cups water. Let stand 5 or more hours; drain. To every gallon of pickles, allow one tablespoon mustard. Place in jar, alternate layers of cucumbers, onions, dill and a few slices horseradish root well washed, and mixed spices, and pour over all, equal parts of vinegar and water. Cover and let stand in warm place for 3 days. Cover pickles with bag filled with mustard seeds. Place cover on jar and keep in a cool dry place. Ready for use in 3 days if placed in sun.

SWEET PICKLED RIPE CUCUMBER

1 doz. ripe cucumbers,	2 tablespoons mustard seeds,
3 lbs. sugar,	1 tablespoon cloves,
1 qt. vinegar,	heads removed,
Stick cinnamon.	

Peel cucumbers, cut in two, lengthwise, scrape out seeds with a silver spoon, salt and let stand over night. Drain and dry cucumbers. Make a syrup of the sugar and vinegar. Add the mustard seed and also the whole cinnamon and cloves tied in a bag. Boil cucumbers in this syrup only until they are glassy. They must remain crisp. Pack in jats and cover air-tight.

MIXED PICKLES

2 qts. tiny cucumbers,	1 large green pepper, sliced,
2 qts. large cucumbers cut in ¼ inch slices,	1½ cups salt to 2 qts. water,
	½ cup horseradish root, diced,
2 qts. small white onions,	¼ lb. yellow mustard seed,
1 qt. string beans, cut,	1½ gallons cider vinegar,
2 large cauliflowers,	1 lb. brown sugar,
flowerettes, separate,	1 teaspoon red pepper,
3 small red peppers, and	1 oz. tumeric.

Mix first 7 ingredients, pour over salt water, let stand 24 hours, drain. Boil the rest and pour over pickles, let stand 2 days. Pour into jars and seal.

CHOW-CHOW (MUSTARD PICKLES)

1 qt. very small cucumbers,	4 green peppers, chopped,
1 qt. large cucumbers, cut,	1 cup salt to 4 qts. water,
1 qt. green tomatoes, sliced	6 tablespoons mustard,
1 qt. onions, sliced,	1 teaspoon powdered tumeric,
1 qt. small onions,	1 cup flour,
1 qt. cauliflower,	1½ cups sugar,
3 pints vinegar.	

Mix the first 7 ingredients, cover with the salt water and let stand 24 hours. Heat the brine slowly until vegetables are thoroughly scalded and then drain. Mix the flour, sugar, mustard and tumeric to a smooth paste with one pint of the vinegar, pour gradually on the remaining quart of vinegar, heated in double boiler. Cook until thick, (do not boil) then add to the hot vegetables. Pack into clean, hot jars and seal.

DILL BEANS

1 pk. wax beans,	½ oz. black peppercorns,
4 qts. water,	6 bay leaves,
1 cup salt,	6 grape or cherry leaves,
2 large stalks dill,	fresh,
1 cup vinegar.	

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Remove strings and cook beans in boiling, salted water 5 to 7 minutes, (1 teaspoon salt to 1 qt. boiling water.) Drain and pack in layers, in a crock, add a few peppercorns, a little dill, some pieces of bay leaf; repeat, covering top layer well with dill and adding the grape or cherry leaves. Follow recipe for Summer Dill Pickles, page 560.

GREEN DILL TOMATOES

Select small firm green tomatoes, follow recipe for Winter or Summer Dill Pickles.

PICKLED CABBAGE

4 qts. thinly sliced cabbage, red or white,	¼ cup mustard seed,
	¼ cup mixed pickle spices,
4 teaspoons fine salt,	1 cup sugar,
½ teaspoon pepper,	2 qts. vinegar.

Select large, heavy cabbage, take off the outside leaves; cut in quarters and then in thin shreds, using cabbage cutter. Sprinkle the salt over cabbage, mix thoroughly, and let stand over night. Drain slightly and add the pepper and mustard seed, mix and place in crock. Add sugar and pickle spices, tied in a bag, to the vinegar, bring to the boiling point slowly and pour boiling hot over the cabbage to cover. If after cooling the vinegar does not cover cabbage, add more hot vinegar. May be used cold, or, not cover cabbage, add more hot vinegar. May be used cold, or when heated, as a vegetable, in place of sauerkraut. Will keep indefinitely.

PICKLED BEANS

1 pk. wax beans,	1 cup vinegar,
3 tablespoons salt,	½ cup sugar,
5 qts. boiling water,	8 pint cans.

Remove strings and cut beans into 1 inch pieces; wash and cook in the boiling, salted water (1 teaspoon salt to 1 quart water), until tender, but still crisp. Drain beans and save the water in which they were cooked. Reserve enough of this bean liquor to fill cans, add the sugar and vinegar. When hot, add drained beans. When boiling, pour at once into the cans. Use as a salad or sweet sour vegetable.

SWEET PICKLED BEANS

1 pk. of string beans cooked until tender,	1 quart water,
	1 lb. sugar,
1 quart vinegar,	1 tablespoon cloves,

1 stick cinnamon (broken).

Wash and pick over the beans, string and cut. Boil in salt water (1 teaspoon to 1 quart of boiling water), until tender. Drain and spread out to dry; then pack into air-tight cans. Boil until a nice syrup is obtained. Let cool, then pour in cans and seal.

PICKLED ONIONS

4 quarts small white onions,	2 quarts vinegar,
	2 cups sugar,
1 cup salt,	¼ cup mixed pickle spices.

Peel onions under water, add salt and let stand over night. Place in colander, pour plenty cold water over to rinse and let drain. Tie spices in thin bag. Boil with sugar and vinegar, throw in onions, let boil up and pour at once to overflowing, into air-tight bottles or jars.

PICKLED BEETS

No. 1

1 qt. cold, boiled beets, sliced,	1 teaspoon brown sugar,
1 teaspoon salt,	1 teaspoon caraway seed,
⅛ teaspoon pepper,	1 pint vinegar.

Boil Beets, page 204, place in crock in layers, sprinkle with salt, pepper, sugar, caraway seed, and cover with vinegar.

No. 2

Scrub thoroughly and boil beets, page 204, until tender and skin them. To 3 cups of the beet water add 1 cup sugar, 2 cups of vinegar, a few cloves and a little mace. Let this come to a boil, add beets. When thoroughly heated put in jars and seal.

PICKLED CAULIFLOWER

4 heads cauliflower,	2 qts. vinegar,
1 cup salt,	2 cups sugar,

¼ cup mixed pickle spices.

Separate flowerettes of cauliflower, add the salt and let stand over night. Place in colander, rinse with cold water and let drain. Tie spices in thin bag and boil with vinegar and sugar, throw in the cauliflower, boil a few minutes and pour to overflowing in wide mouthed bottles or cans. Cork or cover and seal air-tight.

SAUERKRAUT

15 heads cabbage,	A round board,
2½ lbs. salt,	A small square of cloth,
24 tart apples,	A heavy stone,
A wooden stamper,	An 8-gallon stone jar.

Select large, heavy cabbages, remove outer leaves, cut in quarters, remove core, and slice very fine on large cabbage cutter. Into a large granite pan, place 5 pounds of the shredded cabbage, sprinkle with ¼ cup of salt, mix thoroughly and then pack into the large crock; add, if desired, a cup of apples, cut fine and then pound and stamp down the cabbage with a wooden stamper, until the brine flows and covers the cabbage. Mix another 5 pounds of cabbage and ¼ cup of salt, and pack again into crock, cover with 1 cup chopped apples and pound as before until covered with brine. Continue until all cabbage is used, always pounding until covered with brine. Now cover with cabbage leaves, lay on the fitted square of cloth, then the board and stone, to help keep the contents under brine. Use large crock and leave enough space on top for the cabbage to swell or ferment, without overflowing.

Put in a warm place to ferment. In two weeks examine, remove the scum, if any; wash cloth, picking it up at the corners to catch all of the scum; wash board, stone and sides of crock; cover again with cloth, board and stone; then remove to cool place and remove scum and wash cloth, etc., weekly.

Or pack, when fermented, in jars. Cover with the brine, heat thoroughly in a water bath and seal, page 587. If not enough "Kraut" brine, mix ¼ cup salt with 1 quart of water.

SALTED BEANS OR CORN

String beans and corn may be preserved for winter use in stone crocks or jars by packing in salt or brine, 1 pound salt to 4 pounds beans.

Salted Beans Beans should be left whole or cut in 2-inch pieces or lengthwise and prepared for cooking and blanched 3 minutes.

Sprinkle a layer of salt at the bottom of the crock, then a layer of beans, then salt and repeat until the jar is full, top layer salt. Place plate over top of beans, to press down well. Let stand over night. If sufficient brine has not formed in 24 hours, add 1 pound salt to 2 quarts water and pour enough of this brine over beans to cover well. Cover with cloth, then plate or board and a weight. Wash off cloth if scum arises. When ready to use soak over night and cook as fresh beans.

Salted Corn—Husk the ears of corn and remove the silk. Cook in boiling water for about 10 minutes to set the milk. Cut off the corn from the cob with a sharp knife. Weight the corn and pack in layers, using 1 pound salt for every 4 pounds of corn. Proceed as with Salted Beans.

When ready to use, soak over night and then prepare as you would the fresh variety.

SALTED CUCUMBERS FOR FUTURE USE

Cucumbers picked fresh from the vines every day may be preserved in strong salt brine and when wanted made into sweet, sour, or mixed pickles. Leave from ¼ to ½ inch stems on cucumbers, wash carefully without removing the prickles, put them, as they are gathered into a large stone crock. Make enough brine to half fill the crock and have the pickles completely covered with the brine.

Brine—For every two (2) quarts of water take two (2) cups of salt, or enough salt to float an egg. Boil, skim until clear, then cool. When ready to use, soak in cold water for 24 hours or until freshened.

CATSUPS AND RELISHES

TOMATO CATSUP

NO. 1

30 tomatoes,	3 cups sugar,
12 apples,	5 tablespoons salt,
5 green peppers,	1 teaspoon cinnamon,
10 onions,	½ teaspoon cayenne pepper,

1 qt. vinegar.

Cook first four ingredients until soft, strain through colander, then through sieve. Add the rest and boil slowly for one hour until thick. Bottle while hot and seal.

No. 2

1 peck ripe tomatoes,	½ cup sugar,
4 onions,	½ tablespoon cayenne
1 small clove of garlic,	½ cup all together, of cassia buds, whole allspice and stick cinnamon,
2 red peppers, seeded,	
2 bay leaves,	
2 tablespoons salt,	1 pint vinegar.

Boil first 6 ingredients until soft, strain through colander and then through sieve. Tie whole spices in bag. Add to strained tomatoes, with sugar. Boil rapidly without scorching 1½ hours until thick or reduced ½. Remove spice bag, add vinegar, boil 10 minutes longer or until thick. Bottle while hot and seal.

CHILI SAUCE

No. 1

18 large tomatoes,	2 tablespoons salt,
6 large onions,	1 cup sugar,
1 pint vinegar.	

Scald, peel and chop tomatoes, peel onions, put through coarse grinder. Boil altogether slowly 1 hour or longer, stirring well, and pour in hot, clean jars, and seal.

No. 2

50 medium ripe tomatoes,	1 tablespoon whole cloves,
10 medium onions,	1 tablespoon whole cinnamon,
4 red peppers, seeds removed,	
1 large bunch celery,	3 cups sugar,
1 quart vinegar,	2 tablespoons salt,
1 tablespoon whole allspice,	1 nutmeg, grated.

Scald, peel and chop the tomatoes, and put in colander to drain. Chop all the vegetables. Mix and then boil 2½ hours. Tie whole spices in a bag, boil 15 minutes longer. Bottle while hot, and seal.

TOMATO RELISH

No. 1

1 pk. ripe tomatoes,	2 cups granulated sugar,
2 cups chopped onions,	1 cup mustard seed,
2 cups chopped celery,	½ cup salt,
2 qts. cider vinegar,	1 teaspoon black pepper,
4 red peppers, chopped fine,	1 teaspoon paprika.

Chop and peel tomatoes and put in colander to drain, add rest of the ingredients and fill to overflowing in jars and cover tightly. Ready for use in 6 weeks.

No. 2

1 pk. ripe tomatoes,	¼ cup celery seed,
6 large onions,	2 qts. vinegar,
8 red or green peppers,	2 lbs. sugar,
1 bunch celery,	1 cup salt.

Put tomatoes, onions and peppers through food chopper. Place in bag over night with salt, to drain. Add celery, cut fine, and celery seed. Boil sugar and vinegar and let cool, and pour cold over mixture. Place in wide mouthed bottles and seal.

PEPPER RELISH

12 large red peppers,	1 pt. vinegar,
12 large green peppers,	3 cups sugar,
15 onions, chopped fine,	3 tablespoons salt,
Vinegar,	3 tablespoons mustard seed.

Remove seeds from peppers and chop or grind; mix with the onions and pour boiling water over the mixture. Let stand 5 minutes, then drain. Make a weak solution of vinegar, taking 1 part vinegar and 2 parts water. Put pepper mixture in the vinegar, let come to a boil; let stand 10 minutes, then drain again. Add 1 pint vinegar, the salt and sugar, let come to a boil, boil 2 minutes, and then bottle and seal.

ENGLISH CHUTNEY SAUCE

1 lb. of apples, chopped,	¼ cup mint leaves, chopped,
¾ lb. raisins, chopped,	1 oz. white mustard seed,
1 dozen ripe tomatoes, chopped,	¼ cup salt,
	2 cups granulated sugar,
2 red peppers, chopped,	1½ qts. vinegar, boiled and cooled.
6 small onions, chopped,	

Chop tomatoes. The rest put through the meat chopper. Place in preserving kettle, bring to boiling point. Cook slowly until thick and clear, fill into small, sterilized jars, and seal.

CORN RELISH

No. 1

1 qt. raw corn,	1 onion,
3 cups cabbage,	1 cup sugar,
1 cup stalk celery,	2 tablespoons salt,
2 red peppers, seeded,	3 tablespoons mustard,
2 green peppers, seeded,	3 cups vinegar.

Grind or chop the first 6 ingredients, add the rest of the ingredients, cook until corn is tender and bottle and seal.

No. 2

20 ears corn,	½ cup salt,
1 medium head cabbage,	2 cups sugar,
4 green peppers,	½ cup flour,
6 red peppers,	½ teaspoon tumeric,
4 onions, chopped,	¼ lb. mustard,
1 cup celery, chopped,	1 qt. white vinegar.

Cut corn from cob; cabbage, onion and pepper through food grinder. Mix flour, tumeric and mustard. Stir in the vinegar gradually at first, then let come to a boil. Add the rest and boil ½ hour. Bottle, add more vinegar if necessary. Seal.

CUCUMBER RELISH

2 green cucumbers,	Few grains cayenne pepper,
1 cup salt,	2 tablespoons horseradish,
1 cup vinegar,	2 tablespoons onion and green pepper, chopped,
¼ cup sugar,	
1 pint celery, cut fine,	1 teaspoon pepper.

Peel and chop 2 large, thin cucumbers (about 1 pint) add equal amount of celery. Sprinkle with salt and let stand over night in cheesecloth bag. Rinse thoroughly. Let drain. Add the rest. Place in small jars. Seal.

GREEN TOMATO PICKLES (DELMONICO)

½ pk. green tomatoes, sliced,	2 lbs. brown sugar,
	¼ lb. white mustard seed,
¼ pk. skinned onions,	¼ oz. celery seed,
1 pt. salt,	1 oz. tumeric powder,
3 large cucumbers, diced,	2 tablespoons stick cinnamon,
3 red peppers, seeded and chopped,	
	2 tablespoons cloves, heads removed.
½ gallon cider vinegar,	

Mix tomatoes and onions with the salt and sprinkle a little salt over the cucumbers. Let stand 24 hours, pour off brine, then soak 12 hours in cold water. Tie spices in a bag and place into a kettle with the vinegar and sugar, heat to the boiling point, add the pickles and let simmer slowly for 1 hour. Fill into airtight cans and keep in a cool place.

SPANISH PICKLE

½ peck green tomatoes,	3 tablespoons salt,
1 dozen red peppers,	3 cups sugar,
1 dozen green peppers,	3 cups vinegar,
1 medium head cabbage,	3 tablespoons mustard seed,
10 large onions,	1 teaspoon tumeric.

Put the first 5 ingredients through the food chopper, add the salt, let stand over night. Drain. Mix with the rest of the ingredients and boil 20 minutes. Pour into jars and seal.

MOCK MINCE MEAT (GREEN TOMATOES)

1 peck green tomatoes,	1 cup vinegar,
1 tablespoon salt,	1 tablespoon cinnamon,
4 lbs. sugar,	½ tablespoon cloves,
1 lb. raisins, seeded,	2 oranges, rind and juice,
1 lb. dried currants,	1 lemon, rind and juice.

Wash, pick over and chop the tomatoes in small pieces. Place in colander, pour boiling water over them 3 times, draining well each time. Remove to preserving kettle, add sugar, raisins and currants, well washed and boil slowly until tender. Add vinegar, let cool, then add the rest. Use as a filling for pie.

BEET AND HORSERADISH RELISH

No. 1

2 qts. boiled beets, chopped,	2 cups sugar,
2 qts. cabbage, chopped,	2 teaspoons salt,
1 cup horseradish, grated,	Pepper to taste.

Boil beets, page 204, mix ingredients, add cold vinegar to cover, and place in gallon jar. Will keep.

No. 2

3 cups cold, boiled beets,	1 teaspoon salt,
½ cup horseradish root,	¾ cup vinegar,
¼ teaspoon pepper,	2 tablespoons sugar.

Boil, peel and chop beets, page 204, and grate the horseradish; season with salt, pepper and sugar. Add all the vinegar, the horseradish and beets will absorb, or mix lemon juice with the vinegar and place in covered jar or glass and it is ready for use. Will keep a long time. Canned beets and bottled horseradish may be used.

Buckeye Cookery 1881

CANNING FRUITS.

Cleanse the cans thoroughly and test to see if any leak or are cracked. If tin cans leak, send them to the tinner; if discolored inside they may be lined with writing-paper just before using. In buying stoneware for canning purposes, be sure that it is well glazed, as fruits canned in jars or jugs imperfectly glazed sometimes become poisonous. Never use defective glass cans, but keep them for storing things in the pantry; and in buying them, take care that they are free from flaws and blisters, else the glass will crumble off in small particles when subjected to heat. Self-sealers are very convenient, but the heat hardens the rubber rings, which are difficult to replace, so that in a year or two they are unfit for use. For this reason many prefer those with a groove around the top for sealing with wax or putty. The latter is very convenient, as jars sealed with it can be opened readily with a strong fork or knife, and are much more easily cleaned than when wax-sealed. Putty may be bought ready for use, and is soon made soft by molding in the hand. In using it should be worked out into a small roll, and pressed firmly into the groove with a knife, care being taken to keep it well pressed down as the can cools. In canning, provide a wide-mouthed funnel (made to set into the can), and pour the fruit into a funnel from a bright tin dipper (if old or rusty it will discolor the fruit) or a small pitcher, heated before putting in the hot fruit to prevent breaking. Pour fruit as quickly as possible, and screw down top immediately.

Fruit should be selected carefully, and all that is imperfect rejected. Large fruits, such as peaches, pears, etc., are in the best condition to can when not quite fully ripe, and should be put up as soon as possible after picking; small fruits, such as berries, should never stand over night if it is possible to avoid it. The highest-flavored and longest-keeping fruits are best put up without paring, after having carefully removed the down with a fine but stiff brush. Use only the best sugar in the proportion of half a pound of sugar to a pound of good fruit, varying the rule, of course, with the sweetness of the fruit. Or, in canning for pies omit sugar, as the natural flavor is better preserved without it, and some prefer this method for all purposes. It is economical, and well worthy of experiment. Cans put up in this way should have a special mark so as to distinguish them from the rest. When ready to can, first place

the jars (glass) in a large pan of warm water on the back of the stove, make ready the syrup in a nice clean porcelain kettle, add the fruit —it is better to prepare only enough fruit or syrup for two or three cans at a time—and by the time it is done, the water in the pan will be hot and the cans ready for use. Take them out of the water and set them on a hot platter, which answers the double purpose of preventing their contact with any cold surface like the table, and saving any fruit that may be spoiled. Fill as full as possible, and set aside where no current of air will strike them; or, better, wring out a towel wet in hot water and set them on it; let stand a moment or two or until wiped off, when the fruit will have shrunk away a little; fill up again with hot syrup, or if you have none, boiling water from the tea-kettle will do, and then seal. In canning peaches, the flavor is improved by adding two or three whole peaches, or dropping in the center of the can a few of the stones. For peaches, pears and berries, some sweeten as for eating, let stand until sugar is dissolved (using no water), place on stove in porcelain kettle and keep at boiling point long enough to heat the fruit, and then can in glass jars as directed.

There are several other ways of preparing glass cans for fruit, among them the following: Wring a towel from cold water, double and wrap closely about and under the can so as to exclude the air, and put a cold silver spoon inside and fill; or, put a towel in a steamer, set in the cans, and place over a kettle of *cold* water, boil the water, and when ready to fill, remove the cans and wrap in a towel wrung from warm water, put a table-spoon rinsed in hot water inside, and fill; or, wash the cans in tepid water, place an iron rod inside, and at once pour in the boiling fruit, but not too fast. In using glass cans with tops which screw on, be sure that the rubbers are firm and close-fitting, and throw away all that are imperfect. When the can is filled to overflowing, put on the top at once and screw down tightly, and as the fruit and cans cool, causing contraction of the glass, turn down again and again until perfectly air-tight. Wrap as soon as cold with brown wrapping-paper, unless the fruit-closet is *very dark*. Light injures all fruit, but especially tomatoes, in which it causes the formation of citric acid, which no amount of sugar will sweeten. The place where canned fruits are kept should also be dry and *cool*, for if too warm the fruit will spoil. In canning, use a porcelain-lined kettle, silver fork or broom splint and wire spoon or dipper; a steel fork discolors the fruit.

Cans should be examined two or three days after filling, and if syrup leaks out from the rim, they should be unsealed, the fruit thoroughly cooked and kept for jam or jelly, as it will have lost the delicacy of color and flavor so desirable in canned fruits. Pint cans are better for berries than quart. Strawberries keep their color best in stone jars; if glass cans are used for them, they should be buried in sand. If syrup is left after canning berries, it may, while thin, be flavored with vinegar, boiled a moment, and then bottled and corked for a drink mixed with ice-water.

In using self-sealing cans the rubber ring must show an even edge all round, for if it slips back out of sight at any point, air will be admitted. On opening tin cans, remember to pour *all* the fruit out into an earthen or glass dish. If any part is not used at the time, re-cook, and return to dish, and it will keep for a day or two, many of the less perishable fruits longer. Wines, cider, shrubs, etc., must be bottled, well corked, sealed, and the bottles placed on their sides in a box of sand or sawdust. To can maple syrup, pour hot into cans or jugs, and seal well.

The fine display of canned fruits at the Centennial Exhibition was prepared as follows: The fruits were selected with great care, of uniform size and shape, and *all perfect*. They were carefully peeled with a thin, sharp, silver fruit-knife, which did not discolor them, and immediately plunged into cold water in an earthen or wooden vessel to prevent the air from darkening them. As soon as enough for one can was prepared, it was put up by laying the fruit piece by piece in the can, and pouring syrup, clear as crystal, over it, and then, after subjecting the whole to the usual heat, sealing up.

The following table gives the time required for cooking and the quantity of sugar to the quart for the various kinds of fruit.

	Time for boiling fruit.	Quant. sugar to qt.		Time for boiling fruit.	Quant. sugar to qt.
Cherries	5 min.	6 oz.	Peaches, whole	15 min.	4 oz.
Raspberries	6 "	4 "	Pine apples, sliced	15 "	6 "
Blackberries	6 "	6 "	Siberian crab-apples	25 "	8 "
Strawberries	8 "	8 "	Sour apples, quartered	10 "	5 "
Plums	10 "	10 "	Ripe currants	6 "	8 "
Whortleberries	5 "	8 "	Wild grapes	10 "	8 "
Pie Plant, sliced	10 "	8 "	Tomatoes	20 "	none.
Small sour pears, whole	30 "	4 "	Gooseberries	8 "	8 "
Bartlett pears, halved	20 "	6 "	Quinces, sliced	15 "	10 "
Peaches	8 "	4 "			

Canned Berries.

Select those the skins of which have not been broken, or the juice will darken the syrup; fill cans compactly, set in a kettle of cold water, with a cloth beneath them, over an even heat; when sufficiently heated, pour over the berries a syrup of white sugar dissolved in boiling water (the richer the better for keeping, though not for preserving the flavor of the fruit), cover the cans closely to retain heat on the top berries. To insure full cans when cold, have extra berries heated in like manner to supply the shrinkage. If the fruit swims, pour off surplus syrup, fill with hot fruit, and seal up as soon as the fruit at the top is thoroughly scalded.—*Miss L. Southwick.*

Plain Canned Berries.

Pick out stems or hulls if any—if gathered carefully the berries will not need washing, put in porcelain kettle on the stove, adding a small tea-cup water to prevent burning at first. When they come to a boil, skim well, add sugar to taste (for pies it may be omitted), let boil five minutes, fill in glass, stone, or tin cans, and seal with putty unless self-sealers are used. This rule applies to raspberries, blackberries, currants, gooseberries, or any of the small berries.

Canned Currants.

Look them over carefully, stem and weigh them, allowing a pound of sugar to every one of fruit; put them in a kettle, cover, and leave them to heat slowly and stew gently for twenty or thirty minutes; then add the sugar, and shake the kettle occasionally to make it mix with the fruit; do not allow it to boil, but keep as hot as possible until the sugar is dissolved, then pour it in cans and secure the covers at once. White currants are beautiful preserved in this way.—*Mrs. Wm. Patrick, Midland, Mich.*

Green Gooseberries.

Cook the berries in water until white, but not enough to break them; put into cans with as little water as possible, fill up the can with boiling water and seal; when opened pour off water and cook like fresh berries.—*Mrs. O. M. S.*

Canned Peaches.

Pour boiling water over one peck of large clingstone peaches to remove the fuzz; make a syrup of three pounds sugar and one pint vinegar, using a little water if required to cover the peaches; cook until pretty soft, and can as usual.—*Mrs. Frank Stahr, Lancaster, Pa.*

Canned Peaches.

Have one porcelain kettle with boiling water and another with a syrup made sweet enough with white sugar for the peaches; pare, halve, and drop them into the boiling water, let them remain until a silver fork will pierce them, lift them out with a wire spoon, fill can, pour in all the boiling syrup the can will hold, and seal immediately. Continue in this way, preparing and sealing only one can at a time, until done; boil down the water in first kettle with the syrup, if any is left; if not, add more sugar, and quite a nice marmalade will result. This manner of canning peaches has been thoroughly tested, and is pronounced by the experienced the best of all methods.—*Mrs. R. A. Sharp, Kingston.*

Canned Peaches Steamed.

To peel, place in a wire basket, to the handle of which a cord has been tied, let down into boiling water for a moment, then into cold water, and strip off the skin (this saves both fruit and labor). The fruit must be at a certain stage to be prepared in this way, for if too green it will not peel, and if too ripe it will be too much softened by the hot water. After peeling, seed and place in a steamer over a kettle of boiling water, first laying a cloth in bottom of steamer; fill about half full of fruit, cover tightly, make a syrup in a porcelain kettle for fruit alone, let the fruit steam until it can be easily pierced with a silver fork, drop gently for a moment into the hot syrup, place in the cans, fill, cover, and seal. The above recipe is for canning a few at a time. This recipe, with the exception of mode of peeling, applies equally well to pears.

Canned Peaches.

Pare, halve and seed; make a syrup of a pint granulated sugar to a quart water, place on stove in a porcelain kettle (enough for two quart cans). When syrup boils, drop in enough fruit for one can; watch closely, testing with a silver fork, so that the moment they are done they may be removed. When the peaches are tender, lift very gently with a wire spoon, and place in the can previously heated, according to instructions for preparing glass cans. When full of peaches pour in the hot syrup, place the cover on and seal at once; then add more peaches to the hot syrup for next can, and repeat the operation. If there are *more* peaches than will fill the can, place them in another can and *keep hot* until more are ready, and so on until all are canned. Skim the syrup before adding peaches, making only enough syrup at one time for two cans.—*Mrs. W. W. W.*

Canned Pears.

Prepare and can precisely like peaches in preceding recipe, except that they require longer cooking. When done they are easily pierced with a silver fork.

Canned Pie Plant.

Cut the pie plant in pieces, two inches long, put over a slow fire with its weight in sugar; when sugar is dissolved let it boil slowly until clear, but do not let it cook long enough to become dark colored. Put up in air-tight cans.

Canned Pine-Apple.

Peel and slice, make syrup in proportion of two and a half pounds best white granulated sugar to nearly three pints of water; boil five minutes; skim or strain; add fruit and let it boil; have cans hot; fill and seal up as soon as possible.

Canned Plums.

Wash and put whole into a syrup made in the proportion of a pint of water and a pound of sugar to every two pounds of fruit; boil for eight minutes, can, and seal immediately. If pricked with a fork before placing in syrup, they will be less liable to burst. Cherries are canned in the same way.

Raspberries with Currant Juice.

Ten pounds of red or black raspberries, twelve pounds of granulated sugar, one quart currant juice. Make syrup of the sugar and juice; when boiling add the fruit, and continue for ten minutes. Put in glass cans and fasten immediately.

Canned Strawberries.

Fill glass jars with fresh whole strawberries, sprinkled with sugar in the proportion of half pound sugar to a pound of berries, lay covers on lightly, stand them in a wash boiler filled with water to within an inch of tops of cans (the water must not be more than milk-warm when the cans are placed in it). When it has boiled for fifteen minutes, draw to back of stove, let steam pass off, roll the hand in a towel, lift out cans, and place on a table. If the berries are well covered with their own juice, take a table-spoon and fill up the first can to the very top of the rim from the second, wipe the neck, rub dry, and screw the top down firmly, observing carefully the general directions for canning berries. Fill another from the second can, and so on until all are finished. Great care must be taken to keep the berries whole and round; as the cans cool invert them occasionally, to prevent the fruit from forming in a mass at one end.

Canned Strawberries.

For every quart of *fresh* strawberries, take one coffee-cup of white sugar; add a table-spoon or two of water to the fruit if there is no juice in the bottom, to prevent burning before the heat brings out the juice. As soon as the fruit boils, add the sugar, and stir gently for a few minutes until it boils up again, and can immediately. It is better not to cook any more fruit than can be put into one glass fruit-jar. Usually a few spoonfuls of the syrup will be left with which to begin the next can. Strawberries are considered difficult to keep, but there need be no trouble if the fruit is fresh and the can is closed air-tight in glass, and kept as directed in general directions for canning fruits.—*Mrs. H. S. Huntington, Galesburg, Ill.*

Canned Corn.

Dissolve an ounce tartaric acid in half tea-cup water, and take one table-spoon to two quarts of sweet corn; cook, and while boiling hot, fill the cans, which should be tin. When used turn into a colander, rinse with cold water, add a little soda and sugar while cooking, and season with butter, pepper and salt.—*Miss Lida Cartwell.*

Canned Corn and Tomatoes.

Scald, peel, and slice tomatoes (not too ripe) in the proportion of one-third corn to two-thirds tomatoes; put on in a porcelain kettle, let boil fifteen minutes, and can immediately in tin or glass (if glass keep in the dark). Some take equal parts of corn and tomatoes, preparing them as above. Others, after cutting the corn from the cob, cook it twenty minutes, adding a little water and stirring often, then prepare the tomatoes as above, cooking in a separate kettle five minutes, and then adding them to the corn in the proportion of one-third corn to two-thirds tomatoes, mixing well until they boil up once, and then canning immediately.—*Mrs. D. Buxton.*

String-Beans.

String fresh string-beans, break in several pieces, cook in boiling water ten minutes, and can like tomatoes.—*Mrs. L. W. C., Cincinnati.*

Canned Tomatoes.

The tomatoes must be entirely fresh and not overripe; pour over them boiling water, let stand a few minutes, drain off, remove the

skins, and slice crosswise into a stone jar, cutting out all the hard or defective portions; cook for a few minutes in their own juice, skimming off the scum which rises, and stirring with a wooden spoon or paddle; have the cans on the hearth filled with hot water; empty, and fill with hot tomatoes; wipe moisture from tops with soft cloth, put on and secure covers. If tin cans are used, press down covers, and pour hot sealing wax into grooves. If put up in glass, set away in a dark place. Either tin, glass or stone cans may be used, and all may be sealed with putty instead of wax, it being more convenient. (See general instructions for canning fruit.)

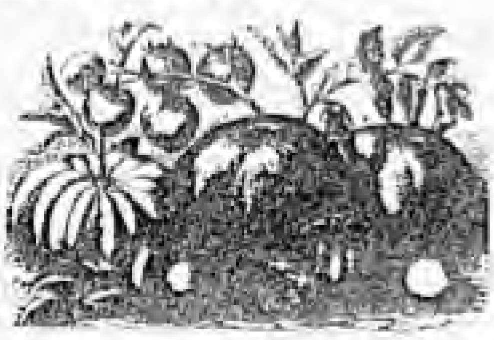
Canned Watermelon.

Cut rind of ripe melons (first cutting off all green parts) into small pieces two or three inches long, and boil until tender enough to pierce with fork; have a syrup made of white sugar, allowing half pound sugar to a pound fruit; skim out melon and place in syrup together with a few pieces of race ginger, let cook a few minutes, put in cans and seal hot.

Warranted Canned Strawberries.

Put four pounds white sugar in a kettle, add a teacup cold water, let boil till perfectly clear, then add four quarts nice berries. Boil ten minutes, keeping them covered with syrup, but avoid stirring in order to preserve their good appearance. Take out berries with a small strainer or skimmer, place in a crock and let the syrup boil ten minutes longer, then pour it over berries, and, when cool, fill the cans, putting a tablespoon of good brandy on top of each can, screw on lid tightly, and put in a *dry dark* place. This method is the only means of preserving the peculiar flavor of the strawberries. To prevent the second handling, put the hot berries in the cans (instead of the crock) till about three quarters full. When syrup has boiled, fill each can with it, let stand till cool, then cover with the tablespoon of brandy (take out a little juice if necessary) and screw on the lid.

If after two or three weeks the least fermentation appears, put the cans in a boiler (on a small board to prevent contact with bottom), fill with cold water nearly to top of cans, loosen the lids, but do not take them off, let water boil for a little while, then take out cans, *tighten the covers* and the berries will keep over a year. Fully ripe currants and acid cherries canned in same manner, one pound of sugar to one of dressed fruit, are delicious. They never need a second boiling if carefully prepared.



CATSUPS AND SAUCES.

Always select perfect fruit; cook in porcelain, never in metal. In making catsup, instead of boiling, some sprinkle the tomatoes with salt and let them stand over night, then strain and add spices, etc., and a little sugar. Bottle in glass or stone, and never use tin cans; keep in a cool, dry, dark place. If, on opening, there is a leathery mold on top, carefully remove every particle of it, and the catsup will not be injured. To prevent this molding, some do not fill the bottles quite to the top with catsup, but fill up with hot vinegar. If there are white specks of mold all through the catsup it is spoiled. If, on opening and using a part, there is danger that the rest may sour, scald, and, if too thick, add vinegar. Sauces should always be made with great care in a pan set in hot water, having the sauce pan *clean* if a delicate flavor is desired, especially if the sauce is drawn butter. Butter and those sauces containing eggs should never boil. Wooden spoons must be used for stirring. An excellent thickening for soups, sauces and gravies is prepared as follows: Bring butter just to the boiling point in a small stew-pan, dredge in flour, stirring together until well cooked. This, when not cooked brown, is "White Roux," and when browned, "Brown Roux." Thin this with a part of the soup, sauce or gravy, and add it to the whole, stirring thoroughly. The flour may be browned before using if intended for brown gravies or sauces. Melted butter may be used in place of oil in all recipes where the latter is named.

Mint, when used in recipes, usually means "spearmint" or "green mint," though pennyroyal and peppermint are of the same family. The young leaves of from one to six inches in length are the parts used. It grows on any good garden soil, but comes forward earlier in a warm, sunny spot. It is propagated by cuttings or dividing the roots of old plants in the spring, is very prolific, and ought to find a place in every garden. Those who have conservatories should keep a root in pots, to use with spring lamb before the leaves would appear in the open air. Mint leaves for drying should be cut from the stalks just before the plant blossoms, and spread out thinly in some dry, shady place, where they can dry slowly. When dry, put up in paper bags and keep in a dry place until wanted.

Cucumber Catsup.

Three dozen cucumbers and eighteen onions peeled and chopped very fine; sprinkle over them three-fourths pint table-salt, put the whole in a sieve, and let drain well over night; add a tea-cup mustard seed, half tea-cup ground black pepper; mix well, and cover with good cider vinegar.—*Mrs. Hattie Clemmons, Asheville, N. C.*

Currant Catsup.

Four pounds nice fully-ripe currants, one and a half pounds sugar, table-spoon ground cinnamon, a tea-spoon each of salt, ground cloves and pepper, pint vinegar; stew currants and sugar until quite thick, add other ingredients, and bottle for use.

Gooseberry Catsup.

Nine pounds gooseberries, five pounds sugar, one quart vinegar, three table-spoons cinnamon, one and a half each allspice and cloves. The gooseberries should be nearly or quite ripe. Take off blossoms, wash and put them into a porcelain kettle, mash thoroughly, scald and put through the colander, add sugar and spices, boil fifteen minutes, and add the vinegar cold; bottle immediately before it cools. Ripe grapes prepared by same rule, make an excellent catsup.—*Mrs. Col. W. P. Reid, Delaware, Ohio.*

Tomato Catsup.

Half bushel tomatoes, four ounces salt, three ounces ground black pepper, one ounce cinnamon, half ounce ground cloves, one drachm cayenne pepper, one gallon vinegar; slice the tomatoes and stew in their own liquor until soft, and rub through a sieve fine enough to retain the seeds; boil the pulp and juice down to the consistency of apple-butter (very thick), stirring steadily all the time to prevent burning; then add the vinegar with which a small tea-cup sugar and

the spices have been mixed, boil up twice, remove from fire, let cool and bottle. Those who like the flavor of onions may add about half a dozen medium-sized ones, peeled and sliced, fifteen minutes before the vinegar and spices are put in.—*Mrs. M. M. Munsell, Delaware, Ohio.*

Tomato Catsup.

Take one bushel of firm ripe tomatoes—the Feejee Island, known by their pink or purple color, and the "Trophy," are the best and richest varieties for catsup and canning. Wipe them off nicely with a damp cloth, cut out the cores, and put them in a porcelain-lined iron kettle or a genuine bell-metal one. Place over the fire, and pour over them about three pints of water, throw in two large handfuls of peach leaves, with *ten* or twelve onions or shallots cut fine. Boil until the tomatoes are done, which will take about two hours; then strain through a coarse-mesh sieve, pour the liquid back again into the boiling kettle and add half a gallon of good strong cider vinegar; have ready two ounces ground spice, two ounces ground black pepper, two ounces mustard (either ground or in the seed, as you prefer), one ounce ground cloves, two grated nutmegs, two pounds light brown sugar, and one pint of salt; mix these ingredients well together before putting in the boiler; then boil two hours, stirring continually to prevent burning. If you like the catsup "hot," add cayenne pepper to your taste. When cool, fill bottles (reeded bottles are the nicest, they can be procured at the house furnisher's, and a set will last some time; they look better than ones of all sizes and styles). Cork and seal with bottle-wax so as to exclude the air. Keep in a cool, dry place for future use. This recipe is preferred to all others—it has been used for years. It keeps well, and has been pronounced by competent judges superior to all others.—*G. D., Baltimore, Md.*

Bread Sauce.

Place a sliced onion and six pepper-corns in half a pint of milk over boiling water, until onion is perfectly soft; pour it on half a pint of bread crumbs without crust, and leave it covered for an hour; beat it smooth, add pinch of salt, and two table-spoons butter rubbed in a little flour; add enough sweet cream or milk to make it the proper consistency, and boil a few minutes. It must be thin enough to pour.—*Mrs. J. L. T., Denver, Col.*

Bread Sauce.

Half pint grated bread crumbs, one pint sweet milk, and one onion; boil until the sauce is smooth, take out onion and stir in two spoons butter with salt and pepper; boil once and serve with roast duck or any kind of game.—*Mrs. H. C. E.*

Cranberry Sauce.

After removing all soft berries, wash thoroughly, place for about two minutes in scalding water, remove, and to every pound fruit add three-quarters of a pound granulated sugar and a half pint water; stew together over a moderate but steady fire. Be careful *to cover* and *not to stir* the fruit, but occasionally shake the vessel, or apply a gentler heat if in danger of sticking or burning. If attention to these particulars be given, the berries will retain their shape to a considerable extent, which adds greatly to their appearance on the table. Boil from five to seven minutes, remove from fire, turn into a deep dish, and set aside to cool. If to be kept, they can be put up at once in air-tight jars. Or, for strained sauce, one and a half pounds of fruit should be stewed in one pint of water for ten or twelve minutes, or until quite soft, then strained through a colander or fine wire sieve, and three-quarters of a pound of sugar thoroughly stirred into the pulp thus obtained; after cooling it is ready for use. Serve with roast turkey or game. When to be kept for a long time without sealing, more sugar may be added, but its too free use impairs the peculiar cranberry flavor. For dinner-sauce half a pound is more economical, and really preferable to three-quarters, as given above. It is better, though not necessary, to use a porcelain kettle. Some prefer not to add the sugar till the fruit is almost done, thinking this plan makes it more tender, and preserves the color better.—*C. G. & E. W. Crane, Caldwell, N. J.*

Celery Sauce.

Scrape the outside stalks of celery and cut in pieces an inch long, let stand in cold water half hour, then put in boiling water enough to cover, and cook until tender; drain off water and dress with butter, salt, and milk or cream, thickened with a little flour; Or, make a dressing by adding to half pint milk or cream, the well-beaten yolks of two eggs, a bit of butter, and a little salt and pepper or grated nutmeg; bring just to boiling point, pour over stewed celery, and serve with roast duck.—*Mrs. A. Wilson.*

Cream Sauce.

Heat one table-spoon butter in a skillet, add a tea-spoon flour, and stir until perfectly smooth, then add gradually one cup of cold milk, let boil up once, season to taste with salt and pepper, and serve. This is very nice for vegetables, omelets, fish, or sweet breads.

Curry Powder.

An ounce of ginger, one of mustard, one of pepper, three of coriander seed, three of turmeric, one-half ounce cardamom, quarter ounce cayenne pepper, quarter ounce cumin seed; pound all fine, sift and cork tight. One tea-spoon of powder is sufficient to season any thing. This is nice for boiled meats and stews.—*Mrs. C. Fullington.*

Chili Sauce.

Twelve large ripe tomatoes, four ripe or three green peppers, two onions, two table-spoons salt, two of sugar, one of cinnamon, three cups vinegar; peel tomatoes and onions, chop (separately) very fine, add the peppers (chopped) with the other ingredients, and boil one and a half hours. Bottle and it will keep a long time. Stone jugs are better than glass cans. One quart of canned tomatoes may be used instead of the ripe ones. This Chili sauce is excellent and much better and more healthful than catsups.—*Mrs. E. W. Herrick, Minneapolis, Minn.*

Caper Sauce.

To a pint of drawn butter, add three table-spoons of capers. Serve with boiled or roast mutton. Another method is the following: Fifteen minutes before the mutton is done, melt two table-spoons butter in a sauce-pan, stir into it one table-spoon flour; when thoroughly mixed add half a pint of the liquor in which the mutton is boiling, and half a pint of milk, season with pepper and salt, cook a few minutes (to swell the grains of the flour), and just before serving (in order that their color may not be lost by standing) add two heaped table-spoons capers.

Caper Butter.

Chop one table-spoon of capers very fine, rub through a sieve with a wooden spoon, and mix them with a salt-spoon of salt, quarter of a salt-spoon of pepper, and one ounce of cold butter. Put a layer of this butter on a dish, and serve fish on it.

Drawn Butter.

Rub a small cup of butter into half a table-spoon flour, beating it to a cream, adding, if needed, a little salt; pour on it half a pint boiling water, stirring it fast, and taking care not to let it *quite* boil,

as boiling makes it *oily* and unfit for use. The boiling may be prevented by placing the sauce-pan containing it in a larger one of boiling water, covering and shaking frequently until it reaches the boiling point. A great variety of sauces which are excellent to eat with fish, poultry, or boiled meats, can be made by adding different herbs, such as parsley, mint, or sweet marjoram, to drawn butter. First throw them into boiling water, cut fine, and they are ready to be added, when serve immediately, with two hard-boiled eggs, chopped fine. This makes a nice sauce to serve with baked fish. The chopped inside of a lemon with the seeds out, to which the chicken liver has been added, makes a good sauce for boiled chicken. For anchovy sauce, add two tea-spoons of anchovy extract or paste (kept by all grocers) to a half pint of drawn butter sauce, and stir well. For lobster sauce, chop the meat of the tail and claws of a good-sized lobster into pieces (not too small). Half an hour before dinner, make half a pint of drawn-butter, add the chopped lobster, a pinch of coral, another of cayenne, and a little salt. When done it should not be a solid mass, but the pieces of lobster should appear distinctly in the thin cream.

Green Tomato Sauce.

Cut up two gallons of green tomatoes; take three gills black mustard seed, three table-spoons dry mustard, two and a half of black pepper, one and a half allspice, four of salt, two of celery seed, one quart each of chopped onions and sugar, and two and a half quarts good vinegar, a little red pepper to taste. Beat the spices and boil all together until well done.

Hollandaise Sauce.

Beat half a tea-cup butter in a bowl to a cream, add yolks of two eggs, one by one, then juice of half a lemon, a pinch of cayenne pepper, half a tea-spoon salt; place this in a sauce-pan of boiling water, beat with an egg beater, for a minute or two, until it begins to thicken, then add one-half cup of boiling water, beating all the time. When like soft custard it is done. It will take five minutes to cook if the bowl is thin and the water boils all the time.

Lemon Sauce.

Cut three slices of lemon into very small dice, and put them into drawn butter, let it come just to boiling point, and pour over boiled fowls.

Mayonnaise Sauce.

Mix in a two-quart bowl one even tea-spoon ground mustard, one of salt, and one and a half of vinegar; beat in the yolk of a raw egg, then add very gradually half a pint pure olive-oil (or melted butter), beating briskly all the time. The mixture will become a very thick batter. Flavor with vinegar or fresh lemon-juice. Closely covered it will keep for weeks in a cold place, and is delicious.

Mint Sauce.

Take fresh, young mint, strip leaves from stems, wash, drain on a sieve, or dry them on a cloth; chop very fine, put in a sauce-tureen, and to three heaped table-spoons mint add two of pounded sugar; let remain a few minutes well mixed together, and pour over it gradually six table-spoons of good vinegar. If members of the family like the flavor, but not the substance of the mint, the sauce may be strained after it has stood for two or three hours, pressing it well to extract all the flavor. It is better to make the sauce an hour or two before dinner, so that the vinegar may be impregnated with the mint. The addition of three or four table-spoons of the liquor from the boiling lamb is an improvement.

Oyster Sauce.

Set a basin on the fire with half pint oysters, from which all bits of shell have been picked, and one pint boiling water; let boil three minutes, skim well, and then stir in half a cup butter beaten to a cream, with two table-spoons flour; let this come to a boil, and serve with boiled turkey. Or, make drawn butter, add a few drops lemon-juice, a tablespoon of capers, or a few drops vinegar, add oysters drained of the liquor, and let come to boiling point. The sauce is richer if cream instead of water is used in making the drawn butter, but in this case do not add the lemon-juice or vinegar.—*Mrs. H. C. M.*

Onion Sauce.

Boil three or four white onions till tender, mince fine; boil half pint milk, add butter half size of an egg, salt and pepper to taste, and stir in minced onion and a table-spoon of flour which has been moistened with milk.—*E. H. W.*

Roman Sauce.

Put one tea-cup water and one tea-cup milk on fire to scald, and when hot stir in a table-spoon flour, previously mixed smooth with a very little cold water, add three eggs well beaten and strained, season with salt and pepper, two table-spoons butter and a little vinegar; boil four eggs hard, slice and lay over the dish; pour over sauce, and serve with boiled fish.—*Mrs. E. T. E.*

Tartare Sauce.

Yolks of two eggs, gill of salad-oil (or melted butter), salt-spoon salt, half a salt-spoon pepper, a table-spoon good cider vinegar, half tea-spoon mustard, a table-spoon of gherkins. Beat together in a small bowl lightly the vinegar and yolks, add to these, drop by drop, the salad-oil or melted butter, taking care to stir the same way all the time; when this is done, season the mixture with pepper, salt and mustard; add also the gherkins finely chopped (or capers may be substituted), and serve in a gravy boat with boiled salmon or cold meats.

Tomato Sauce.

Stew ten tomatoes with three cloves, and pepper and salt, for fifteen minutes (some add a sliced onion and sprig of parsley), strain through a sieve, put on the stove in a saucepan in which a lump of butter the size of an egg and level table-spoon flour have been well mixed and cooked; stir all until smooth and serve. Canned tomatoes may be used as a substitute.

Prepared Mustard.

Take three tea-spoons ground mustard, one of flour (two if the mustard seems very strong), half tea-spoon of sugar; pour boiling water on these and mix into a smooth, thick paste; when cold add vinegar enough to make ready for use, and serve with salt. This resembles the French mustard.—*Mrs. Mary Herbert Huntington.*

To Prepare Horse-radish for Winter.

In the fall, mix the quantity wanted in the following proportions: A coffee-cup of grated horse-radish, two table-spoons white sugar, half tea-spoon salt, and a pint and a half cold vinegar; bottle and seal. To make horse-radish sauce, take two table-spoons of the above, add one dessert-spoon olive oil (or melted butter or cream), and one of prepared mustard.

JELLIES AND JAMS.

Jellies were formerly reputed nourishing, digestible, and fit food for sick and delicate persons, but modern investigation places them second to the lean part of animals and birds. When made of gela-

tine, they have no nutrition, and are simply used to carry a palatable flavor.

Always make jellies in a porcelain kettle, if possible, but brass may be used if scoured very bright and the fruit is removed immediately on taking from the fire. Use the best refined or granulated sugar, and do not have the fruit, especially currants and grapes, overripe.

To extract the juice, place fruit in kettle with just enough water to keep from burning, stir often, and let remain on the fire until thoroughly scalded; or a better but rather slower method is to place it in a stone jar set within a kettle of tepid water, boil until the fruit is well softened, stirring frequently, and then strain a small quantity at a time through a strong coarse flannel or cotton bag wrung out of hot water, after which let it drain, and squeeze it with the hands as it cools, emptying the bag and rinsing it off each time it is used. The larger fruits, such as apples and quinces, should be cut in pieces, cores removed if at all defective, water added to just cover them, boiled gently until tender, turned into bag and placed to drain for three or four hours, or over night. Make not over two or three pints of jelly at a time, as larger quantities require longer boiling. As a general rule allow equal measures juice and sugar. Boil juice rapidly ten minutes from the first moment of boiling, skim, add sugar, and boil ten minutes longer; or spread the sugar in a large dripping-pan, set in the oven, stir often to prevent burning, boil the juice just twenty minutes, add the hot sugar, let boil up once, and pour into the jelly glasses immediately, as a thin skin forms over the surface which keeps out the air; cover with brandied tissue paper, cut to fit glass closely, cool quickly and set in a dry, cool, dark place. Jelly should be examined toward the end of summer, and if there are any signs of fermentation, reboil. Jelly needs more attention in damp, rainy seasons than in others. To test jelly, drop a little in a glass of very cold water, and if it immediately falls to the bottom it is done; or drop in a saucer, and set on ice or in a cool place; if it does not spread, but remains rounded, it is finished. Some strain through the bag into the glasses, but this involves waste, and if skimming is carefully done is not necessary. A little butter or lard, rubbed with a cloth on the outside of glasses or cans, will enable one to pour in the boiling fruit or liquid, the first spoon or two slowly, without breaking the glass. If jelly is not very firm, let it stand in the sun covered with bits of window-glass or pieces of mosquito netting, for a few days. Never attempt to make jelly in damp or cloudy weather if firmness and clearness are desired. Use a wooden or silver spoon to stir, dip with earthen cup, and cook in porcelain-lined kettles. Currants and berries should be made up as soon as picked; never let them stand over night. When ready to put away, cover with pieces of tissue or writing-paper cut to fit and pressed closely upon the jelly, and put on the lid or cover with thick paper, brushed over on the inside with the white of an egg, and turned down on the outside of glass.

Apple or Blackberry Jelly.

Prepare nice, tart, juicy apples as in general directions, using three quarters of a pint of sugar to a pint of juice. Prepare blackberry jelly according to general directions for berries.

Calf's-foot Jelly.

Cut across the first joint, and through the hoof, place in a large sauce-pan, cover with cold water, and bring quickly to the boiling point; when water boils, remove them, and wash thoroughly in cold water. When perfectly clean put into a porcelain-lined sauce-pan, add cold water in the proportion of three pints to two calf's feet, put sauce-pan over fire, and when water boils, set aside to a cooler place, where it will simmer very slowly for five hours; strain the liquor through a fine sieve, or a coarse towel, let it stand over night to set, remove the fat that has risen to the top, dip a towel in boiling water, and wash the surface, which will be quite firm. Now place in a porcelain-lined sauce-pan, and melt, add juice of two lemons, rinds of three cut into strips, one-fourth pound of cut loaf-sugar, ten cloves, and one inch of cinnamon stick. Put the whites of three eggs, together with the shells (which must first be blanched in boiling water), into a bowl, beat them slightly, and pour them into the sauce-pan, continuing to use the egg-beater until the whole boils, when the pan should be drawn aside where it will simmer gently for ten minutes, skimming off all scum as it rises. While simmering, prepare a piece of flannel by pouring through it a little warm water; and when the jelly has simmered ten minutes, pour it through this bag into a bowl, and repeat the process of straining until it is perfectly clear, when add a half gill of sherry (or brandy, or brandy and sherry mixed in equal proportions), stir well, pour into molds, and place upon ice or in a cool place until jelly sets and becomes firm enough to turn out and serve.

Currant Jelly.

Do not pick from the stem, but carefully remove all leaves and imperfect fruit, place in a stone jar, and follow general directions; or place one pint currants, picked off the stem, and one pint sugar, in the kettle on the stove, scald well, skim out currants, and dry on plates; or make into jam with one-third currants and two-thirds raspberries, straining juice after sweetening, and cooking until it "jellies." After currants are dried put them in stone jars and cover closely.—*Mrs. A. R. M.*

Cranberry Jelly.

Prepare juice as in general directions, add one pound sugar to every pint, boil and skim, test by dropping a little into cold water (when it does not mingle with the water it is done), rinse glasses in cold water before pouring in the jelly to prevent sticking. The pulp may be sweetened and used for sauce.—*C. G. & E. W. Crane, Caldwell, N. J.*

Crab Apple Jelly.

Wash and quarter large Siberian crabs, but do not core, cover to the depth of an inch or two with cold water, and cook to a mush; pour into a coarse cotton bag or strainer, and when cool enough, press or squeeze hard, to extract all the juice. Take a piece of fine Swiss muslin or crinoline, wring out of water, spread over a colander placed over a crock, and with a cup dip the juice slowly in, allowing plenty of time to run through; repeat this process twice, rinsing out the muslin frequently. Allow the strained juice of four lemons to a peck of apples, and three quarters of a pound of sugar to each pint of juice. Boil the juice from ten to twenty minutes; while boiling sift in the sugar slowly, stirring constantly, and boil five minutes longer. This is generally sufficient, but it is always safer to "try it," and ascertain whether it will "jelly." This makes a very clear, sparkling jelly.—*Mrs. Carol Gaytes, Riverside, Ill.*

Coffee Jelly.

Half box Coxe's gelatine soaked half an hour in a half tea-cup cold water (as little water as possible), one quart strong coffee, made as if for the table and sweetened to taste; add the dissolved gelatine to the hot coffee, stir well, strain into a mold rinsed with cold water just before using, set on ice or in a very cool place, and serve with whipped cream. This jelly is very pretty, formed in a circular mold with tube in center; when turned out fill the space

in center with whipped cream heaped up a little.—*Mrs. A. Wilson, Rye, N. Y.*

Easter Jelly.

Color calf's-foot jelly a bright yellow by steeping a small quantity of dried saffron leaves in the water. Pare lemons in long strips about the width of a straw, boil in water until tender, throw them into a rich syrup, and boil until clear. Make a blanc-mange of cream, color one third pink with poke berry syrup, one-third green with spinach, and leave the other white. Pour out eggs from a hole a half inch in diameter in the large end, wash and drain the shells carefully, set them in a basin of salt to fill, and pour in the blanc-mange slowly through a funnel, and place the dish in a refrigerator for several hours. When ready to serve, select a round, shallow dish about as large as a hen's nest, form the jelly in it as a lining, scatter the strips of lemon peel over the edge like straws, remove the egg-shells carefully from the blanc-mange, and fill the nest with them.—*Mrs. C. M. Coates, Philadelphia.*

Four-Fruit Jelly.

Take equal quantities of ripe strawberries, raspberries, currants, and red cherries, all should be fully ripe, and the cherries must be stoned, taking care to preserve the juice that escapes in stoning, and add it to the rest. Mix the fruit together, put it into a linen bag, and squeeze it thoroughly; when it has ceased to drip, measure the juice, and to every pint allow a pound and two ounces of the best loaf-sugar, in large lumps. Mix the juice and sugar together; put them in a porcelain-lined preserving kettle, and boil for half an hour, skimming frequently. Try the jelly by dipping out a spoonful, and holding it in the open air; if it congeals readily it is sufficiently done. *This jelly is very fine.—Mrs. E. S. Miller.*

Grape Jelly.

Prepare fruit and rub through a sieve; to every pound of pulp add a pound of sugar, stir well together, boil slowly twenty minutes, then follow general directions; or, prepare the juice, boil twenty minutes, and add one pound of sugar to one pound of juice after it is reduced by boiling; then boil ten or fifteen minutes. Or put on grapes just beginning to turn, boil, place in jelly-bag and let drain; to one pint juice add one pint sugar, boil twenty minutes, and just before it is done add one tea-spoon dissolved gum-arabic.

Lemon Jelly.

Three good-sized lemons sliced, half a pound white sugar, two ounces isinglass or gelatine dissolved in two quarts of cold water, a stick of cinnamon, and a little grated nutmeg. Beat the whites of three or four eggs, and when the gelatine is all dissolved stir them well with the other ingredients; boil five minutes, strain through a flannel jelly-bag into molds and set on ice; or the eggs, cinnamon and nutmeg may be omitted.—*Miss Ella L. Starr.*

Orange Jelly.

Two quarts water, four ounces gelatine, nine oranges and three lemons, a pound sugar, whites of three eggs; soak gelatine in a pint of water, boil the three pints water and sugar together, skim well, add dissolved gelatine, orange and lemon juice, and beaten whites; let come to a boil, skim off carefully all scum, boil until it jellies, and pour jelly into mold. Strain, scum and add to mold.

Peach Jelly.

Crack one-third of the kernels and put them in the jar with the peaches, which should be pared, stoned and sliced. Heat in a pot of boiling water, stirring occasionally until the fruit is well broken. Strain, and to every pint of peach juice add the juice of a lemon. Measure again, and to every pint of peach juice add a pound of sugar. Heat the sugar very hot, and add when the juice has boiled twenty minutes. Let it come to a boil and take instantly from the fire. This is very fine for jelly cake.

Quince Jelly.

Rub the quinces with a cloth until perfectly smooth, cut in small pieces, pack tight in a kettle, pour on cold water until level with the fruit, boil until very soft; make a three-cornered flannel bag, pour in fruit and hang up to drain, occasionally pressing on the top and sides to make the juice run more freely, taking care not to press hard enough to expel the pulp. There is not much need of pressing a bag made in this shape, as the weight of the fruit in the larger part causes the juice to flow freely at the point. To a pint of juice add a pint of sugar and boil fifteen minutes, or until it is jelly; pour into tumblers, or bowls, and finish according to general directions. If quinces are scarce, the parings and cores of quinces with good tart apples, boiled and strained as above, make excellent jelly, and the quinces are saved for preserves.—*Mrs. M. J. W.*

Transcendent Crab-apple Jelly.

Transcendents or any variety of crab-apples, may be prepared as cultivated wild plums, adding flavoring of almond, lemon, peach, pine-apple or vanilla to the jelly in the proportion of one tea-spoon to two pints, or more if it is wished stronger, just before it is done.

Plum Jelly.

If plums are wild (not cultivated) put in pan and sprinkle with soda and pour hot water over them, let stand a few moments and stir through them; take out and put on with water just to cover, or less if plums are very juicy; boil till soft, dip out juice with a china cup; then strain the rest through small salt-bags (by the way, keep them for jelly-bags as they are just the thing), do not squeeze them. Take pound for pound of juice and sugar, or pint for pint, and boil for eight or ten minutes. Jelly will be nicer if only one measure or a measure and a half is made at one time; if more, boil longer; some boil juice ten or fifteen minutes, then add sugar and boil five minutes longer. It can be tested by dropping in a saucer and placing on ice or in a cool place; if it does not spread but remains rounded it is finished. If the plums are the cultivated wild plum, make as above without using the soda. Take the plums that are left and press through a sieve, then take pint for pint of sugar and pulp, boiling the latter half an hour and then adding sugar, boiling ten or fifteen minutes more. Half a pint sugar to a pint, makes a rich marmalade, and one-third pint to pint, boiling it longer, is nice canned, and used for pies, adding milk, eggs and sugar as for squash pies.

Plum-apple jelly may be made by preparing the juice of apples and plums as above (a nice proportion is one part plums to two parts apples; for instance, one peck of plums to two pecks apples); then mixing the juice and finish without flavoring. The marmalade is made in the same way as above. Some add a little ginger root to it. One bushel of apples and one peck of plums make forty pints of jelly, part crab apple and part mixed, and sixteen quart glass cans of mixed marmalade. In making either kind of jelly the fruit may be squeezed and the juice strained twice through swiss or crinoline and made into jelly. The pulp can not then be used for marmalade.

Pie-plant Jelly.

Wash the stalks well, cut into pieces an inch long, put them into a preserving-kettle with enough water to cover them, and boil to a soft pulp; strain through a jelly-bag. To each pint of this juice add a pound of loaf-sugar; boil again, skimming often, and when it jellies on the skimmer remove it from the fire and put into jars.

JAMS.

In making jams, the fruit should be carefully cleaned and *thoroughly* bruised, as mashing it before cooking prevents it from becoming hard. Boil fifteen or twenty minutes before adding the sugar, as the flavor of the fruit is thus better preserved (usually allowing three-quarters of a pound of sugar to a pound of fruit), and then boil half an hour longer. Jams require almost constant stirring, and every house-keeper should be provided with a small paddle with handle at right angles with the blade (similar to an apple-butter "stirrer," only smaller), to be used in making jams and marmalades. Jams are made from the more juicy berries, such as blackberries, currants, raspberries, strawberries, etc.; marmalades from the firmer fruits, such as pine-apples, peaches and apricots. Both require the closest attention, as the slightest degree of burning ruins the flavor. They must be boiled sufficiently, and have plenty of sugar to keep well.

To tell when any jam or marmalade is sufficiently cooked, take out some of it on a plate and let it cool. If no juice or moisture gathers about it, and it looks dry and glistening, it is done thoroughly. Put up in glass or small stone jars, and seal or secure like canned fruits or jellies. Keep jellies and jams in a cool, dry, and dark place.

Currant Jam.

Pick from stems and wash thoroughly with the hands, put into a preserving kettle and boil fifteen or twenty minutes, stirring often, and skimming off any scum that may arise; then add sugar in the proportion of three-fourths pound sugar to one pound fruit, or, by measure, one coffee-cup of sugar to one pint mashed fruit; boil thirty minutes longer, stirring almost constantly. When done, pour in small jars or glasses, and either seal or secure like jelly, by first pressing paper, cut to fit the glasses, down close on the fruit, and then larger papers, brushed on the inside with white of eggs, with the edges turned down over the outside of the glass.

Gooseberry Jam.

Stew the berries in a little water, press through a coarse sieve, return to the kettle, add three-fourths pound sugar to each pound of the pulped gooseberry; boil three-quarters of an hour, stirring constantly; pour in jars or bowls, and cover as directed for currant jams.

Grape or Plum Jam.

Stew in a little water, and press the fruit through a colander or coarse sieve, adding a little water to plums to get all the pulp through; add sugar, and finish as in other jams.

Raspberry Jam.

Make by itself, or, better, combined with currants in the proportion of one-third currants to two-thirds raspberries; mash the fruit well, and proceed as in currant jam.

Make blackberry jam like raspberry, except that it should not be mixed with currants.

Strawberry jam is made exactly like blackberry.

PRESERVES.

Preserves, to be perfect, must be made with the greatest care. Economy of time and trouble is a waste of fruit and sugar. The best are made by putting only a small amount of fruit at a time in the syrup, after the latter has been carefully prepared and clarified, and the fruit neatly pared. Peel peaches, pears, quinces and apples, and throw into cold water as you peel them to prevent their turning dark. It is difficult to watch a large quantity so as to insure its being done to a turn.

The old rule is "a pound of sugar to pound of fruit;" but since the introduction of cans, three-quarters of a pound of sugar to a pound of fruit is sufficient, and even less is sometimes used, the necessity for an excess of sugar having passed away, as preserves may be less sweet, with no risk of fermentation, if sealed. Either tin or glass cans may be used, care being taken to make the sealing perfect.

Quinces, pears, citrons, watermelon-rinds, and many of the smaller fruits, such as cherries, currants, etc., harden when put, at first, into a syrup made of their weight of sugar. To prevent this they should be cooked till tender in water, or in a weak syrup made from a portion only of the sugar, adding the remainder afterward. In preserving fruits, such as apples, peaches, tomatoes, plums and strawberries, and other fruits, which are likely to become too soft in cooking, it is a good plan to pour the hot syrup over the fruit, or to strew over it a part or all the sugar, and allow it to stand a few hours; by either method the juice is extracted, and the fruit hardened. Another approved method of hardening fruit is to skim it out of syrup after cooking a few minutes, and lay it in the hot sun two or three hours, and then pour over it the boiling syrup. Long protracted boiling destroys the pleasant natural flavor of the fruit, and darkens it.

Preserves should boil gently to avoid the danger of burning, and in order that the sugar may thoroughly penetrate the fruit. A good syrup is made in the proportion of half pint water to a pound of sugar. Use loaf or granulated sugar. Put the sugar and water over the fire in a porcelain kettle, and, just before it boils, stir in

the white of an egg beaten lightly with two table-spoons water; and, as it begins to boil, remove the scum with great care; boil until no more scum arises, and then add fruit. Or the white of the egg may be mixed thoroughly with the dry sugar in the kettle, and the boiling water poured over, when all impurities will immediately rise to the surface with the egg, then boil slowly, or rather simmer, until the preserves are clear. Take out each piece with a skimmer and lay on a flat dish to cool, or else put in the jars at once. Stew the syrup, skimming off the scum which rises, until it "ropes" from the spoon. If the preserves are already in the jar pour the syrup over them and seal; if on dishes, return them to the syrup and boil up once before putting up. This is merely a matter of choice, and we have never found any difference in the results of the two methods. Preserves may be made from canned fruit (and some prefer to do this rather than make in the hot season), using less sugar than the rule. When preserving canned peaches or apples, it is an improvement to add a few sliced oranges or lemons. When berries or small fruits are done, take up with a little strainer, and place in cans; if a cup is used, it is impossible to free them from the syrup.

Marmalades, or the different butters, will be smoother and better flavored, and will require less boiling, if the fruit (peaches, quinces, oranges and apples make the best) is well cooked and mashed before adding either sugar or cider. It is important to stir constantly with an apple-butter stirrer.

In making either preserves or marmalades, follow the directions as regards kettle, sugar, and putting up, already given for jellies and jams, covering at once, but not putting away till cold. When preserves are candied, set jar in kettle of cold water, and let boil for an hour; or put them in a crock kept for that purpose, set in oven and boil a few minutes, watching carefully to prevent burning. When specks of mold appear, take them off carefully, and scald preserves as above directed.

Dried fruits are much better and require less boiling, if clean soft water is poured over them and allowed to stand over night. In the morning boil until tender in the water, sweetening five minutes before removing from the stove.

To dry corn or fruits nicely, spread in shallow boxes or box covers, and cover with mosquito netting to prevent flies reaching them. When dry, put up in jars and cover closely, or in paper sacks. Dried peaches are better when halved and the cavities sprinkled with sugar in drying. The fruit must be good, however, as poor fruit can not be redeemed by any process. Another excellent way is to dry them in the oven, and, when about half done, place in a crock a layer of peaches alternately with a layer of sugar. Cherries and currants are excellent dried as follows: Put in jars first a layer of fruit, then a layer of sugar, in the proportion of half a pound sugar to pound of fruit, let stand over night, place them to boil, skimming off all scum, let boil ten or fifteen minutes, skim out and spread on dishes to dry in the sun, or by the fire, turning frequently until dry; then place on pans in oven, stirring with the hand often until the heat is too great to bear. They may then be packed in jars with sugar, or put away in paper sacks, or stone crocks with a cloth tied close over the top, and are an excellent substitute for raisins in puddings or mince-pies.

The secret of keeping dried fruit is to *exclude the light*, and to keep in a *dry and cool* place. Paper sacks, or a barrel or box lined with paper, are secure against moths. Reheating fruit makes it dark in color, and impairs its flavor. Always fill a fruit-can, and keep for present use, to avoid opening the large jars often.

Apple Preserves.

Take three-quarters of a pound sugar to each pound apples; make a syrup of the sugar and water in which root ginger (bruised and tied in a bag) has been boiled until the strength is well extracted, add a little lemon-juice or sliced lemon, skim off all scum, and boil in the syrup a few apples at a time, until they are transparent, and place in jar. When all are done, boil the syrup until thick, pour, boiling hot, over the apples, and cover closely. Well-flavored fruit, not easily broken in cooking, should be used. The ginger may be omitted if disliked.

Carrot Sweetmeats.

Boil small fine-grained carrots in water till tender; peel and grate, add sugar, slips of citron, spices if preferred, and wine; simmer slowly together and put away in jars. Very wholesome for children and very much liked. The juice from any canned fruit sold would take the place of the simple wine used here—the alcoholic mixtures sold in America being utterly unfit for household consumption.—*Mrs. S. Williston, Heidelberg, Germany.*

Cherry Preserves.

Choose sour ones—the early Richmond is good—seed all very carefully, allow an amount of sugar equal to the fruit; take half the sugar, sprinkle over the fruit, let stand about an hour, pour into a preserving-kettle, boil slowly ten minutes, skim out the cherries, add rest of sugar to the syrup, boil, skim and pour over the cherries; the next day drain off the syrup, boil, skim if necessary, add the cherries, boil twenty minutes, and seal up in small jars.—*Mrs. J. M. Southard.*

Citron Preserves.

Pare off rind, seed, cut in thin slices two inches long, weigh, and put in preserving kettle with water enough to cover; boil one hour, take out the melon, and to the water in kettle add as much sugar as there is melon by weight; boil until quite thick, replace melon, add two sliced lemons to each pound of fruit, boil twenty minutes, take out, boil syrup until it is very thick molasses, and pour it over the fruit.—*Mrs. J. H. Robinson, Kenton, Ohio.*

Fig Preserves.

Gather fruit when fully ripe, but not cracked open; place in a perforated tin bucket or wire basket, and dip for a moment into a deep kettle of hot and moderately strong lye (some prefer letting them lie an hour in lime-water and afterwards drain); make a syrup in proportion of one pound sugar to one of fruit, and when the figs are well drained, put them in syrup and boil until well cooked; remove, boil syrup down until there is just enough to cover fruit; put fruit back in syrup, let all boil, and seal up while hot in glass or porcelain jars.—*Ex-Gov. Stearns, Florida.*

Grape Preserves.

Pick grapes from the stems, pop pulps from the skins, doing two at a time, one in each hand between the thumb and forefinger. Put pulp in a porcelain kettle and stew gently until the seeds are loosened; then strain and rub it through a sieve, weigh it with the skins, and to every pound of this allow one pound of granulated sugar. Put skins and juice in kettle, cover closely, and cook slowly until the skins are tender; while still boiling add the sugar, and move the kettle back, as it must not boil again; keep very hot for fifteen minutes, then, seeing that the sugar is thoroughly dissolved, pour the fruit in cans, and screw down the covers as soon as possible.

Pear Preserves.

Pare, cut in halves, core and weigh (if hard, boil in water until tender, and use the water for the syrup), allow three-quarters

pound sugar for each pound fruit, boil a few moments, skim, and cool; when luke-warm add pears, and boil gently until syrup has penetrated them and they look clear; some of the pieces will cook before the rest, and must be removed; when done, take out, boil down syrup a little and pour over them; a few cloves stuck here and there in the pears add a pleasant flavor. Put in small jars with glass or tin tops, and seal with putty.—*Miss Florence Williams.*

Peach Preserves.

Take any fine peaches that do not mash readily in cooking, pare carefully and remove pits; take sugar equal in weight to fruit, (or if to be sealed, three-quarters pound sugar to the pound of fruit), and water in proportion of a half pint to each pound of sugar. Boil pits in the water, adding more as it evaporates, to keep the proportion good, remove pits, add the sugar, clarify, and when the scum ceases to rise, add the fruit, a small quantity at a time; cook slowly about ten minutes, skim out into a jar, add more, and so on until all are done, and then pour the boiling syrup over all. The next day drain off and boil syrup a few minutes only, and pour back, repeating daily until the fruit looks clear. Two or three times is generally sufficient. The last time put up the preserves in small jars, and secure with paper as directed for jellies. If to be sealed in cans, the first boiling is sufficient, after which put into cans and seal immediately. The latter plan is preferable, as it takes less trouble and less sugar, while the natural flavor of the fruit is better retained. Many think peach preserves much nicer if made with maple sugar. Clingstone peaches are preserved in the same way whole, except that they must be put on in clear water and boiled until so tender that they may be pierced with a silver fork before adding the sugar.

Plum Preserves.

Allow equal weights sugar and plums; add sufficient water to the sugar to make a thick syrup, boil, skim, and pour over the plums (previously washed, pricked and placed in a stone jar), and cover with a plate. The next day drain off syrup, boil, skim, and pour in over plums; repeat this for three or four days, place plums and syrup in the preserving-kettle, and boil very slowly for half an hour. Put up in stone jars, cover with papers like jellies, or seal in cans.—*Mrs. J. H. Shearer.*

Plum Sweetmeats.

When Damson plums are perfectly ripe, peel and divide them, taking out the stones; put them over a gentle heat to cook in their own juice; when soft rub them through a sieve, and return to the stove, adding just enough sugar to sweeten, a little cinnamon, and, when nearly done, wine in quantity to suit the taste. This is done more to keep the sweetmeats than for the flavor, as self-sealing cans are not used here, and all preserves are pasted up with the white of eggs. The common wine of the country is thin and sour and is much used in cookery.—*Mrs. L. S. Williston, Heidelberg, Germany.*

Quince and Apple Preserves.

Take equal weights of quinces and sugar, pare, core, leave whole or cut up, as preferred, boil till tender in water enough to cover, carefully take out and put on a platter, add sugar to the water, replace fruit and boil slowly till clear, place in jars and pour syrup over them. To increase the quantity without adding sugar, take half or two-thirds in weight as many fair sweet apples as there are quinces, pare, quarter, and core; after removing quinces, put apples into the syrup, and boil until they begin to look red and clear, and are tender; place quinces and apples in jar in alternate layers, and cover with syrup. For the use of parings and cores, see "Quince Jelly." Apples alone may be preserved in the same way.

Strawberry Preserves.

Put two pounds of sugar in a bright tin-pan over a kettle of boiling water, and pour into it half a pint of boiling water; when the sugar is dissolved and hot, put in fruit, and then place the pan directly on the stove or range; let boil ten minutes or longer if the fruit is not clear, gently (or the berries will be broken) take up with a small strainer, and keep hot while the syrup is boiled down until thick and rich; drain off the thin syrup from the cans, and pour the rich syrup over the berries to fill, and screw down the tops immediately. The thin syrup poured off may be brought to boiling, and then bottled and sealed, to be used for sauces and drinks.

Tomato Preserves.

Scald and peel carefully small perfectly-formed tomatoes, not too ripe (yellow pear-shaped are best), prick with a needle to prevent bursting, add an equal amount of sugar by weight, let lie over night, then pour off all juice into a preserving-kettle, and boil until it is a thick syrup, clarifying with white of an egg; add tomatoes and boil carefully until they look transparent. A piece or two of root-ginger, or one lemon to a pound of fruit sliced thin and cooked with the fruit, may be added.

Watermelon Preserves.

Pare off outside green rind, cut in pieces two inches long, weigh, throw into cold water, skim out, add a heaping tea-spoon each of salt and pulverized alum to two gallons of rinds, let stand until salt and alum dissolve, fill the kettle with cold water, and place on top of stove where it will slowly come to boiling point, covering with a large plate so as to keep rinds under; boil until they can be easily pierced with a fork, drain them from the water, and put into a syrup previously prepared as follows: Bruise and tie in a muslin bag four ounces of ginger-root, and boil in two or three pints of water until it is strongly flavored. At the same time boil in a little water until tender, in another pan, three or four sliced lemons; make a syrup of the sugar and the water in which the lemons and the ginger-root were boiled, add the rinds and slices of lemon to this and boil slowly half to three-quarters of an hour. Citrons may be prepared in the same way, by paring, coring and slicing, or cutting into fanciful shapes with tin cutters made for the purpose.

Apple Butter.

Boil one barrel of new cider down half, peel and core three bushels of good cooking apples; when the cider has boiled to half the quantity, add the apples, and when soft, stir constantly for from eight to ten hours. If done it will adhere to an inverted plate. Put away in stone jars (not earthen ware), covering first with writing-paper cut to fit the jar, and press down closely upon the apple butter; cover the whole with thick brown paper snugly tied down.—*Miss Sarah Thomson, Delaware.*

Egg Butter.

Boil a pint of molasses slowly about fifteen or twenty minutes, stirring to prevent burning, add three eggs well beaten, stirring them in as fast as possible, boil a few minutes longer, partially cool, and flavor to taste with lemon.—*Mrs. Colbert, Broadway.*

Lemon Butter.

Tea-cup white sugar, three eggs, butter the size of half an egg, beat well together; add juice and grated rind of one large lemon, place in a pan set in a kettle of hot water, stir well until thick. This may be made up in quantity, kept for a long time in bottles or jars, and used as needed for filling tarts, etc.

Pumpkin Butter.

Take the seeds out of one pumpkin, cut in small pieces and boil soft; take three other pumpkins, cut them in pieces and boil them

soft, put them in a coarse bag and press out juice; add juice to first pumpkin, and let boil ten hours or more, to become of the thickness of butter; stir often. If the pumpkins are frozen, the juice will come out much easier.

Pie-plant Butter.

Allow one pound of sugar to each pound of peeled and cut up rhubarb; let the rhubarb and sugar simmer gently for an hour, or more if the rhubarb is old and tough. This is a nice preserve, and children should be encouraged to eat it during the winter.

Orange Marmalade.

Twelve pounds sour oranges, twelve pounds crushed sugar; wash the oranges and pare them as you would apples; put the peel in a porcelain-lined kettle with twice its bulk or more of cold water; keep it covered, and boil until perfectly tender; if the water boils away, add more; the peel is generally very hard, and requires several hours boiling; cut the oranges in two crosswise, and squeeze out the juice and the soft pulp, have a pitcher with a strainer in the top, place in a two-quart bowl, squeeze the thin juice and seeds in the strainer and the rest with the pulp in the bowl, drawing the skin as you squeeze it over the edge of the tin strainer, to scrape off the pulp, then pour all the juice and pulp on the sugar; the white skins must be covered with three quarts of cold water, and boiled half an hour, drain the water on the sugar, put the white skins in the colander, four or five together, and pound off the soft part, of which there must be in all two pounds and four ounces, put this with the sugar and juice; when the peel is tender drain it from the water, and choose either of these three modes: Pound it in a mortar, chop it in a bowl, or cut it in delicate shreds with a pair of scissors. There is still another way, which saves the necessity of handling the peel after it is boiled; it is to grate the yellow rind from the orange, then tie it in a muslin bag, and boil until soft, which you can tell by rubbing a little of it between the thumb and finger; it is then ready for the other ingredients; put the whole in a porcelain kettle, or in a bright tin preserving-pan, and boil about an hour; when it begins to thicken it must be tried occasionally, by letting a little cool in a spoon laid on ice. To prevent its burning, pass the spoon often over the bottom of the kettle; when it is thick as desired put it in tumblers and cover with paper.—*Mrs. Elizabeth S. Miller in "In the Kitchen."*

Peach Marmalade.

Choose ripe, well-flavored fruit, and it is well to make with preserves, reserving for marmalade those that are too soft. The flavor is improved by first boiling the pits in the water with which the syrup is to be made. Quarter the peaches and boil thirty minutes before adding sugar, stirring almost constantly from the time the peaches begin to be tender; add sugar in the proportion of three-fourths pound sugar to one pound fruit, continue to boil and stir for an hour longer, and put up in jars, pressing paper over them as directed for jellies.

Quince Marmalade.

Pare, quarter and core quinces, cut in little squares, measure and allow an equal amount of sugar; place the fruit in a porcelain kettle with just water enough to cover, boil till tender, and skim out carefully; make a syrup of the sugar and the water in which the quinces were boiled, let come to boiling point, skim well, and drop the quinces gently in; boil fifteen minutes and dip out carefully into jelly-bowls or molds. The syrup forms a jelly around the fruit so that it can be turned out on a dish, and is very palatable as well as ornamental. In this way quinces too defective for preserves may be used.—*Mrs. Mary A. Cooper.*

Dried Apple Sauce.

Look over, wash thoroughly and soak fifteen minutes in clean warm water; drain, cover with cold soft water, place on the stove, let boil slowly two to four hours, mash fine, sweeten, and season with cinnamon very highly. Never add sugar until about five minutes before removing from the stove, otherwise the fruit will be toughened and hardened. Follow the same direction in preparing dried peaches, only do not mash or season so highly. Cook in porcelain, and do not stir while cooking.

Boiled Cider Apple Sauce.

Pare, quarter and core apples sufficient to fill a gallon porcelain kettle, put in it a half gallon boiled cider, let it boil. Wash the apples and put in kettle, place a plate over them, and boil steadily but not rapidly until they are thoroughly cooked, testing by taking one from under the edge of the plate with a fork. Do not remove the plate until done, or the apples will sink to the bottom and burn. Apples may be cooked in sweet cider in the same way.—*Mrs. W. W. W.*

Preserved Citron.

Boil the citron in water until it is clear and soft enough to be easily pierced with a fork; take out, put into a nice syrup of sugar and water, and boil until the sugar has penetrated it. Take out and spread on dishes to dry slowly, sprinkling several times with powdered sugar, and turning until it is dried enough. Pack in jars or boxes with sugar between the layers.

Tomato Figs.

Scald and skin pear-shaped (or any small-sized) tomatoes, and to eight pounds of them add three pounds brown sugar; cook without water until the sugar penetrates and they have a clear appearance, take out, spread on dishes, and dry in the sun, sprinkling on a little syrup while drying; pack in jars or boxes, in layers with powdered sugar between. Thus put up they will keep for any length of time, and are nearly equal to figs. Peaches may be preserved in the same way.—*Mrs. John Samuels, Covington, Ky.*

Dried Currants.

One pint sugar to a pint of stemmed ripe currants; put them together in a porcelain kettle, a layer of currants at the bottom; when the sugar is dissolved, let them boil one or two minutes, skim from the syrup, and spread on plates to dry in a partly cooled oven. Boil the syrup until thickened, pour it over the currants, and dry it with them. Pack in jars and cover closely. Blackberries may be dried in the same manner. An economical way of making jelly is to boil liquid, skimming well, after currants are taken out, until it becomes jelly, and then put away in jelly glasses.

PICKLES.

In making pickles use none but the best cider vinegar, and boil in a porcelain kettle—never in metal. A lump of alum size of a small nutmeg, to a gallon of cucumbers, dissolved and added to the vinegar when scalding the pickles the first time, renders them crisp and tender, but too much is injurious. Keep in a dry, cool cellar,

in glass or stoneware; look at them frequently and remove all soft ones; if white specks appear in the vinegar, drain off and scald, adding a liberal handful of sugar to each gallon, and pour again over the pickles; bits of horse-radish and a few cloves assist in preserving the life of the vinegar. If put away in large stone jars, invert a saucer over the top of the pickles, so as to keep them well under the vinegar. The nicest way to put up pickles is bottling, sealing while hot, and keeping in a cool, dark place. Many think that mustard-seed improves pickles, especially chopped, bottled, and mangoes, but use it, as well as horse-radish and cloves, sparingly. Never put up pickles in any thing that has held any kind of grease, and never let them freeze. Use an oaken tub or cask for pickles in brine, keep them well under, and have more salt than will dissolve, so that there will always be plenty at the bottom of the cask. The brine for pickles should be strong enough to bear an egg; make it in the proportion of a heaping pint of coarse salt to a gallon of water. Use coarse salt, and test pickles by tasting before putting on vinegar (they should be of a pleasant saltness); if not salt enough, add salt to brine and allow them to stand until they have acquired the proper flavor; if too salt, cover with weak vinegar, and let stand for two or three days, drain, adding strong vinegar, either hot or cold according to recipes, and finish as directed. In the case of kegs of cucumbers kept in brine for a long time, to be used when needed, it is better to err in using too much salt, as this may be corrected by adding the weak vinegar, but if not sufficiently salted the pickles will be insipid. In scalding cucumber pickles to green them, some use cabbage leaves, covering bottom, sides, and top of kettle. A medium spicing for a quart of pickles is a level tea-spoon of peppercorns (whole black peppers), the same of allspice, a table-spoon of broken stick cinnamon, half a tea-spoon of cloves, mustard seed, or horse-radish chopped fine, and one piece of ginger root, an inch long. If ground cayenne pepper is used instead of whole peppers, an eighth of a tea-spoon is enough. A better substitute for peppercorns is garden-peppers cut in rings, in proportion of two rings of green and one of red without seeds, or a level tea-spoon, when finely chopped, to a quart of pickles. These proportions may be increased or decreased to suit the taste, taking care not to put in so much of any one as to make its flavor predominate. Ginger is the most wholesome of the spices. Cloves are the strongest, mace next, then allspice and cinnamon, and, of course, less of the stronger should be used. Pickles are not famous for wholesome qualities, even when made with the greatest care, but if they must be eaten, it is best to make them at home. Those sold in market are often colored a beautiful green with sulphate of copper, which is a deadly poison, or are cooked in brass or copper vessels, which produces the same result in an indirect way. Scalding or parboiling articles to be pickled makes them absorb the vinegar more easily, but does not add to their crispness. Before putting them in vinegar, after parboiling, they should be cold *and perfectly dry*. Always use strong vinegar, or the pickles will be insipid, and it should be scalding hot when poured on, as raw vinegar becomes ropy and does not keep well. As heating weakens it, vinegar for pickles should be *very strong*, and should only be *brought to boiling point*, and *immediately* poured on pickles. Keep pickles from the air, and see that the vinegar is at least two inches over the top of pickles in the jar. A *dry* wooden spoon or ladle should be used in handling pickles, and is the only one that should touch pickles in the jars. If the vinegar loses its strength it should be replaced by good, poured over scalding hot.

Pickled Artichokes.

Rub off outer skin with a coarse towel, and lay in salt water for a day, drain and pour over them cold spiced vinegar, adding a teaspoonful of horse-radish to each jar.

Bean Pickles.

Pick green beans of the best variety, when young and tender, string, and place in a kettle to boil, with salt to taste, until they can be pierced with a fork, drain well through a colander, put in a stone jar, sprinkle with cayenne pepper, and cover with strong cider vinegar; sugar may be added if desired.

Bottled Pickles.

Wash and wipe a half bushel of medium-sized cucumbers, suitable for pickling, pack close in a stone jar, sprinkle over the top one pint of salt, pour over a sufficient quantity of boiling water to cover them, place a cloth over the jar, and let stand until cold (if prepared in the evening, let stand all night), drain off the water, and place the pickles on stove in cold vinegar, let them come to a boil, take out, place in a stone jar, and cover with either cold or hot vinegar. They will be ready for use in a few days, and are excellent. It is an improvement to add a few spices and a small quantity of sugar.

To bottle them, prepare with salt and boiling water as above, drain (when cold), and place a gallon at a time on a stove in enough cold vinegar to cover level (need not be very strong), to which a lump of alum about the size of a small hickory-nut (too much is injurious) has been added. Have on stove, in another kettle, a gallon of the very best cider vinegar, to which add half a pint of brown sugar; have bottles cleaned and placed to heat on stove in a large tin-pan of cold water; also have a tin cup or small pan of sealing-wax heated; on table, have spices prepared in separate dishes, as follows: Green and red peppers sliced in rings; horse-radish root washed, scraped, and cut in small pieces, black and yellow mustard seed (or this may be left out), each prepared by sprinkling with salt and pouring on some boiling water, which let stand fifteen minutes and then draw off; stick cinnamon washed free from dust, and broken in pieces, and a few cloves. When pickles come to boiling point, take out and pack in bottles, mixing with them the spices (use the cloves, horse-radish and mustard seed, sparingly); put in a layer of pickles, then a layer of spices, shaking the bottles occasionally so as to pack tightly; when full cover with the boiling hot vinegar from the other kettle (using a bright funnel and bright tin cup), going over them a second time and filling up, in order to supply shrinkage, for the pickles must be entirely covered with the vinegar. Put in the corks, which should fit very snugly, lift each bottle (wrap a towel around it to prevent burning the hands), and dip the corked end into the hot sealing-wax; proceed in this manner with each bottle, dipping each a second time into the wax so that they may be perfectly secure. If corks seem too small, throw them in boiling water; if too large, pound the sides with a hammer. The tighter they fit in the bottles the better for the pickles. Glass cans, the tops or covers of which have become defective, can be used by supplying them with corks. Pickles thus bottled are far more wholesome than, and are really superior to, the best brand of imported pickles, and, by having materials in readiness, prepared as directed, the process is neither difficult nor tedious. It requires two persons to successfully bottle pickles.—*Mrs. Florence W. Hush, Minneapolis.*

Chow Chow Pickles.

Let two hundred small cucumbers stand in salt and water closely covered for three days. Boil for fifteen minutes in half a gallon

best cider vinegar, one ounce white mustard seed, one of black mustard seed, one of juniper berries, one of celery seed (tying each ounce separately in swiss bags), one handful small green peppers, two pounds sugar, a few small onions, and a piece alum half the size of a nutmeg; pour the vinegar while hot over the cucumbers, let stand a day, repeating the operation three or four mornings. Mix one-fourth pound mustard with the vinegar, pour over cucumbers, and seal up in bottles.—*Mrs. Ada Estelle Bever.*

Chow Chow.

One peck of green tomatoes, half peck string beans, quarter peck small white onions, quarter pint green and red peppers mixed, two large heads cabbage, four tablespoons white mustard seed, two of white or black cloves, two of celery seed, two of allspice, one small box yellow mustard, pound brown sugar, one ounce of turmeric; slice the tomatoes and let stand over night in brine that will bear an egg; then squeeze out brine, chop cabbage, onions and beans, chop tomatoes separately, mix with the spices, put all in porcelain kettle cover with vinegar, and boil three hours.

Cauliflower Pickles.

Choose such as are fine and of full size, cut away all the leaves, and pull away the flowers by bunches; soak in brine that will float an egg for two days, drain, put in bottles with whole black pepper, allspice, and stick cinnamon; boil vinegar, and with it mix mustard smoothly, a little at a time and just thick enough to run into the jars, pour over the cold cauliflower and seal while hot. An equal quantity or less of small white onions, prepared as directed in recipe for onion pickles, may be added before the vinegar is poured over.

Celery Pickles.

Put together in a porcelain-lined kettle two quarts chopped white cabbage, two quarts chopped celery, three quarts vinegar, half ounce each of crushed white ginger root and turmeric, fourth pound white mustard seed, two tablespoons salt, five of sugar; cook slowly several hours until cabbage and celery are tender.

Cucumber Pickles.

Cover the bottom of cask with common salt; gather the cucumbers every other day, early in the morning or late in the evening, as it does not injure the vines so much then as in the heat of the day; cut the cucumbers with a short piece of the stem on, carefully laying them in a basket or pail so as not to bruise; pour cold water over and rinse, being careful not to rub off the little black briers, or in any way to bruise them, as that is the secret of keeping them perfectly sound and good for any length of time. Lay them in a cask three or four inches deep, cover with salt, and repeat the operation until all are in; pour in some water with the first layer—after this the salt will make sufficient brine. Now spread a cloth over them, then a board with a stone on it. When a new supply of cucumbers is to be added, remove stone, board and cloth, wash them very clean, and wipe every particle of scum from the top of the pickles and the sides of the cask; throw away any soft ones, as they will spoil the rest; now put in the fresh cucumbers, layer by layer, with salt to cover each layer. When cask is nearly full, cover with salt, tuck cloth closely around the edges, placing the board and weight on top; cover cask closely, and the pickles will be perfect for two or three years. Cucumbers must always be put in the salt as soon as picked from the vines, for if they lie a day or two they will not keep. Do not be alarmed at the heavy scum that rises on them, but be careful to wash all off the board and cloth. When wanted for pickling, take off weight and board, carefully lift cloth with scum on it, wash stone, board and cloth clean, and wipe all scum off the cucumbers and sides of cask, take out as many as are wanted, return the cloth, board and weight, and cover closely. Place the cucumbers in a vessel large enough to hold two or three times as much water as there are pickles, cover with cold water (some use hot), change the water each day for three days, place the porcelain kettle on the fire, fill half full of vinegar (if vinegar is very strong add half water), fill nearly full of cucumbers, the largest first and then the smaller ones, put in a lump of alum the size of a nutmeg, let come to a boil, stirring with a wire or wooden spoon so as not to cut the cucumbers; after boiling one minute, take out, place in a stone jar, and continue until all are scalded, then pour over them cold vinegar. In two or three days, if the pickles are too salt, turn off the vinegar and put on fresh, add a pint of brown sugar to each two gallons pickles, a pod or two of red pepper, a very few cloves, and some pieces of horse-radish. The horse-radish prevents a white scum from rising.

Chopped Pickles.

Take a peck green tomatoes, wash clean, cut away a small piece from each end, slice and place in a large wooden bowl, chop fine, place in a crock and mix salt with them (half pint to a peck), let stand same time as tomatoes; drain, place again in separate jars, cover each with cold weak vinegar; after twenty-four hours drain cabbage well, pressing hard to extract all the juice; place tomatoes and the vinegar in a porcelain kettle and let them boil for three minutes, stirring all the time, pour out, and when cold, place in a towel and wring and press until perfectly dry; now mix tomatoes and cabbage together, take a double handful at a time, squeeze as tightly as possible, and place in a dry crock; take the stone jar in which they are to be pickled, place in it a layer of tomatoes and cabbage, scatter over with chopped peppers, whole mustard seed, and horse-radish, then another layer of tomatoes and cabbage, next spice, and so on until jar is almost full, occasionally sprinkling with cayenne pepper; cover with strong cider vinegar, to each gallon of which a tea-cup of sugar has been added. Place a saucer or pieces of broken china on the pickles to keep them under the vinegar. If a white scum rises, drain off vinegar, boil, skim, and pour hot over the pickles. Prepare mustard, peppers, and horse-radish, as follows: Take three green or ripe garden peppers (four table-spoons when chopped), cut in two, place in salt water over night, the next morning drain and chop quite fine; to two table-spoons mustard-seed add salt-spoon salt, pour in boiling water, let stand fifteen minutes and drain; two table-spoons horse-radish chopped fine. Tomatoes and onions are excellent prepared in the same way. For sliced pickles, take cucumbers and onions, or tomatoes and onions, and slice and prepare as above.—*Mrs. W. W. W.*

Mangoes.

Select green or half grown muskmelons; remove a piece the length of the melon, an inch and a half wide in the middle and tapering to a point at each end; take out seeds with a tea-spoon, secure one end of each piece to its own melon by a stitch made with a needle and white thread. Make a brine of salt and cold water strong enough to float an egg, pour it over them, and after twenty-four hours take them out. For filling, use chopped tomatoes and chopped cabbage prepared as in "Chopped Pickles," small cucumbers, small white onions, and nasturtium pods, each prepared by remaining in salt water in separate jars twenty-four hours; add also green beans boiled in salt water until tender. For spice, use cinnamon-bark, whole cloves, chopped horse-radish, cayenne pepper, mustard seed, the latter prepared as directed in "Chopped Pickles." Prepare three or four times as much cabbage and tomatoes as of

other articles, as any part left over may be placed in jar with vinegar poured over, and is ready for the table. Use one, or, if small, two cucumbers, two or three onions, and the same quantity of bean and nasturtium pods, placing them in mango first, with two or three cloves, three or four sticks of cinnamon an inch long, and half a tea-spoon horse-radish, and filling up afterward with the chopped cabbage or tomatoes (mixing, or using them separately in alternate melons) pressing down very firmly, so that the mango is filled tight, sprinkling on the cayenne pepper last. Sew in the piece all around in its proper place with strong white thread; when all are thus prepared, place in a stone crock, cover with weak cider-vinegar, let remain over night; in the morning place the mangoes, and the vinegar in which they were soaked, in a porcelain kettle, boil half an hour, place in a jar, cover with good strong cider vinegar, let stand all night; in the morning drain off vinegar and boil it, adding one pint of sugar to each gallon, and pour boiling hot over the mangoes; drain off and boil the vinegar three or four times, and they are done. This is not the usual way of preparing mangoes, but it is much the best. To pickle nasturtiums, soak as collected in salt and water for twenty-four hours, drain, and put into cold vinegar; when all the seed is thus prepared, drain, and cover with fresh boiling-hot vinegar.

Peach Mangoes.

Take unpared, fine, large peaches (freestones); with a knife extract the stone from the side, place in jar, pour over them boiling water salted to taste, let stand twenty-four hours; drop into fresh cold water and allow to remain ten or fifteen minutes; wipe very dry, fill each cavity with grated horse-radish and white mustard-seed (prepared as directed in recipe for "Chopped Pickles), a small piece of ginger-root, and one or two cloves; sew up, and place in a stone jar as close together as possible. Make a syrup in proportion of one pint sugar to three pints vinegar; pour, boiling hot, over them. They will be ready for use in a week, and are very fine.

French Pickles.

One peck green tomatoes sliced, six large onions sliced; mix these and throw over them one tea-cup of salt, and let them stand over night; next day drain thoroughly and boil in one quart vinegar mixed with two quarts of water, for fifteen or twenty minutes. Then take four quarts vinegar, two pounds brown sugar, half pound white mustard-seed, two table-spoons ground allspice, and the same of cinnamon, cloves, ginger, and ground mustard; throw all together and boil fifteen minutes.—*Mrs. President R. B. Hayes, Washington, D. C.*

Pickled Onions.

Select small silver-skinned onions, remove with a knife all the outer-skins, so that each onion will be perfectly white and clean. Put them into brine that will float an egg for three days, drain, place in jar, first a layer of onions three inches deep, then a sprinkling of horse-radish, cinnamon bark, cloves, and a *little* cayenne pepper; repeat until jar is filled, in proportion of half a tea-spoon cayenne pepper, two tea-spoons each chopped horse-radish and cloves, and four table-spoons cinnamon bark, to a gallon of pickles; bring vinegar to boiling point; add brown sugar in the proportion of a quart to a gallon, and pour hot over the onions.—*Estelle Woods Wilcox.*

Piccalilli.

One large white cabbage, fifty small cucumbers, five quarts small string-beans, eight small carrots, one dozen sticks celery, five red peppers, three green peppers, two heads cauliflower; chop fine, soak over night in salt and water, wash well, drain thoroughly, and pour over them hot vinegar spiced with mace, cinnamon and allspice; turn off vinegar and scald until safe to leave like common pickles; or seal in can while hot.—*Mrs. W. L.*

Pyfer Pickles.

Salt pickles down dry for ten days, soak in fresh water one day; pour off water, place in porcelain kettle, cover with water and vinegar, and add a tea-spoon pulverized alum (to each gallon); set over night on a stove which had fire in during the day; wash and put in a jar with cloves, allspice, pepper, horse-radish and onions or garlic; boil fresh vinegar and pour over all; in two weeks they will be ready for use. These pickles are always fresh and crisp, and are made with much less trouble than in the old-fashioned way by keeping in brine.—*Mrs. E. M. R.*

Pickled Peppers.

Take large green ones (the best variety is the sweet pepper), make a small incision at the side, take out all the seeds, being careful not to mangle the peppers; soak in brine that will float an egg for two days, changing water twice; stuff with chopped cabbage, or tomatoes seasoned with spice as for mangoes (omitting the cayenne pepper), or a mixture of nasturtiums, chopped onions, red cabbage, grapes, and cucumbers, seasoned with mustard-seed and a little mace. Sew up incision, place in jar, and cover with cold-spiced vinegar.

Spanish Pickles.

One dozen cucumbers, four heads of cabbage, one peck green tomatoes, one dozen onions, three ounces white mustard-seed, one ounce celery seed, one ounce turmeric, one box Coleman's mustard, two and a half pounds brown sugar. Let the cucumbers stand in brine that will float an egg three days; slice the onions, and chop cabbage and tomatoes, the day before making, and sprinkle with salt in the proportion of half pint to a peck. When ready to make, squeeze brine out of cucumbers, wipe them off, peel and cut them in slices, let all simmer slowly in a kettle together for half an hour, and then bottle.—*Mrs. J. W. Grubbs, Richmond, Ind.*

Ripe Tomato Pickles.

Pare ripe, sound tomatoes (do not scald), put in a jar; scald spices (tied in a bag) in vinegar, and pour while hot over them. This recipe is best for persons who prefer raw tomatoes.

Variety Pickles.

One peck each of green tomatoes and cucumbers, and one quart onions; pare, slice and salt (using a rounded half pint for all) each in separate jars, letting them stand in the salt twenty-four hours, and drain well, wringing and pressing in a cloth; sprinkle fresh green radish-pods and nasturtium seeds with salt, and let stand for the same length of time; boil in water salted to taste two quarts of half-grown, very tender bean pods, until they can be pierced with a silver fork, take out and drain. Now place each in a separate jar, cover with cold, weak vinegar for twenty-four hours, drain well, pressing hard to get out all the juice, cook tomatoes as in "Chopped Pickles," and then mix all well together. In a stone jar place first a layer of the mixture, sprinkle with mustard seed (prepared as directed in recipe for "Chopped Pickles)," horse-radish chopped fine, cinnamon bark, rings of garden peppers, and a few cloves, then another layer of the mixture, then the spice with a light sprinkling of cayenne pepper. The spices used for this amount are nine table-spoons stick cinnamon, four and a half tea-spoons each of mustard-seed, cloves, and horse-radish, and twenty-seven rings of garden peppers. Cover with good cider vinegar, let stand over night, drain off vinegar, and boil in a porcelain kettle, adding brown sugar in the proportion of one pint to a gallon of vin-

egar; skim well, pour hot over the pickles, continue to drain off and boil for several days. If not sweet enough, add more sugar, although these are not intended for sweet pickles. The proportion of cucumbers may be double or even three times the quantity of tomatoes if desired.—*Mrs. W. W. Woods.*

Virginia Mixed Pickle.

One-half peck green tomatoes, twenty-five medium-sized cucumbers, fifteen large white onions, one-half peck small onions, four heads cabbages, one pint grated horse-radish, one-half pound white mustard-seed, one-fourth pound ground mustard, one-half tea-cup ground black pepper, one-half pint salad oil, one ounce celery seed, one-half ounce ground cinnamon, two ounces turmeric. Slice the tomatoes and large onions, cut cabbage as for slaw, quarter cucumbers lengthwise, cut in pieces two inches long, leaving the peel on, and add the small onions whole. Mix with salt thoroughly, let stand twenty-four hours; drain off the juice, and pour vinegar and water over pickles. Let stand a day or two, strain again as dry as possible; mix the spices well except the ground mustard, then boil one and one-half gallons fresh apple vinegar and pour boiling hot over the pickles; do this three mornings in succession, using the same vinegar each time. The third time add one pound of sugar to the vinegar and boil, pouring over as above; also mix the oil and ground mustard together with a small portion of the vinegar, and add when cold. Oil can be omitted if not relished.—*Mrs. H. L. Sperry, Nashville, Tenn.*

Pickled Walnuts.

Gather walnuts (or butternuts) when soft enough to be pierced by a needle (July), prick each with a large needle well through, holding in a cloth to avoid staining the hands, cover with strong salt water (a pint and a half salt to a gallon of water), let stand two or three days, changing the brine every day; then pour over them a brine made by dissolving salt in boiling water (let it get cold before using), let stand three days, renew the brine and let it stand for three days more. Now drain and expose to the sun for two or three days or until they become black, or put in cold water for half a day, and pack in jars not quite full. The proportions are a hundred walnuts to each gallon of vinegar. Boil vinegar eight minutes, with a tea-cup sugar, three dozen each whole cloves and allspice, a dozen and a half pepper-corns, and a dozen blades of mace. Pour the vinegar over the walnuts scalding hot. In three days draw off the vinegar, boil and pour over the walnuts again while hot, and at end of three days repeat the process. They will be fit to eat in a month, and will keep for years.—*Mrs. C. T. Carson.*

SWEET PICKLES.

Sweet pickles may be made of any fruit that can be preserved, including the rinds of ripe melons and cucumbers. The proportion of sugar to vinegar for syrup is three pints to a quart. Sweet pickles may be made of any preserve by boiling over the syrup and adding spices and vinegar. Examine frequently, and re-scald the syrup if there are signs of fermentation. Plums and other smooth-skinned fruits should be well pricked before cooking. The principal spices for sweet pickles are cinnamon and cloves. Use "coffee C," best brown, or good stirred maple sugar.

Sweet Pickled Beets.

Boil them in a porcelain kettle till they can be pierced with a silver fork; when cool cut lengthwise to size of a medium cucumber; boil equal parts vinegar and sugar with half a table-spoon ground cloves tied in a cloth to each gallon; pour boiling hot over the beets.—*Mrs. Samuel Woods, Milford Center, Ohio.*

Pickled Cucumbers.

Prepare and quarter ripe cucumbers, take out seeds, clean, lay in brine that will float an egg nine days, stirring every day, take out and put in clear water one day, lay in alum-water (a lump of alum size of a medium hulled hickory-nut to a gallon of water) over night, make syrup of a pint good cider vinegar, pound brown sugar, two table-spoons each broken cinnamon bark, mace, and pepper grains; make syrup (three pints of sugar to a quart of vinegar) enough to cover the slices, lay them in, and cook till tender.—*Mrs. M. L. France.*

Currant Pickles.

Scald seven pounds ripe currants in three pounds sugar and one quart vinegar, remove currants to jar, boil for a few moments and pour over the fruit. Some add three pounds of raisins and spices. If not sweet enough, use only one pint vinegar.

Pickled Grapes.

Fill a jar with alternate layers of sugar and bunches of nice grapes just ripe and freshly gathered; fill one-third full of good cold vinegar, and cover tightly.—*Mrs. C. T. Carson.*

Spiced Grapes.

Five pounds grapes, three of sugar, two tea-spoons cinnamon and allspice, half tea-spoon cloves; pulp grapes, boil skins until tender, cook pulp and strain through a sieve, add it to the skins, put in sugar, spices and vinegar to taste; boil thoroughly and cool.—*Miss Mar Stokes, Milford Center.*

Spiced Gooseberries.

Leave the stem and blossom on ripe gooseberries, wash clean; make a syrup of three pints sugar to one of vinegar, skim, if necessary, add berries and boil down till thick, adding more sugar if needed; when almost done, spice with cinnamon and cloves; boil as thick as apple butter.

Spiced Nutmeg Melon.

Select melons not quite ripe, open, scrape out the pulp, peel, and slice; put the fruit in a stone jar, and, for five pounds fruit, take a quart vinegar, and two and a half pounds sugar; scald vinegar and sugar together, and pour over the fruit; scald the syrup and pour over the fruit each day for eight successive days. On the ninth, add one ounce stick-cinnamon, one of whole cloves, and one of allspice. Scald fruit, vinegar and spices together, and seal up in jars. This pickle should stand two or three months before using. Blue plums are delicious prepared in this way.—*Mrs. Gen. Noyes.*

Peach Pickles.

Pare freestone peaches, place in a stone jar, and pour over them boiling-hot syrup made in the proportion of one quart best cider vinegar to three pints sugar; boil and skim, and pour over the fruit boiling hot, repeating each day until the fruit is the same color to the center, and the syrup like thin molasses. A few days before they are finished, place the fruit, after draining, in the jar to the depth of three or four inches, then sprinkle over bits of cinnamon bark and a few cloves, add another layer of fruit, then spice, and so on until the jar is full; scald the syrup each morning for three or four days after putting in the spice, and pour syrup boiling hot over fruit, and, if it is not sufficiently cooked, scald fruit with the syrup the last time. The proportion of spices to a gallon of fruit is, two tea-spoons whole cloves, four table-spoons cinnamon. To pickle clingstones, prepare syrup as for free-stones; pare fruit,

put in the syrup, boil until they can be pierced through with a silver fork; skim out, place in jar, pour the boiling syrup over them, and proceed and finish as above. As clings are apt to become hard when stewed in sweet syrup, it may often be necessary to add a pint of water the first time they are cooked, watching carefully until they are tender, or to use only part of the sugar at first, adding the rest in a day or two. Use the large White Heath clingstones if they are to be had. All that is necessary to keep sweet pickles is to have syrup enough to cover, and to keep the fruit well under. Scald with boiling syrup until fruit is of same color throughout, and syrup like thin molasses; watch every week, particularly if weather is warm, and if scum rises and syrup assumes a whitish appearance, boil, skim, and pour over the fruit. If at any time syrup is lacking, prepare more as at first.—*Mrs. M. J. Woods.*

Pear Pickles.

Prepare syrup as for peaches, pare and cut fruit in halves, or quarters if very large, and if small leave whole, put syrup in porcelain kettle, and when it boils put in fruit, cook until a silver fork will easily pierce them; skim out fruit first and place in jar, and last pour over syrup boiling hot; spice like peach pickles, draining them each day, boiling and skimming the syrup, and pouring it boiling hot over the fruit until fully done. By cooking pears so much longer at first they do not need to be boiled so frequently, but they must be watched carefully until finished, and if perfectly done, will keep two or more years. Apple pickles may be made in the same way, taking care to select such as will not lose shape in boiling.

Spiced Plums.

Nine pounds blue plums, six pounds sugar, two quarts vinegar, one ounce cinnamon; boil vinegar, sugar and spice together, pour over plums, draw off next morning and boil, pour back on plums, repeat the boiling five mornings, the last time boiling the fruit about twenty minutes.—*Mrs. Capt. W. B. Brown, Washington City.*

Pickled Raisins.

Leave two pounds raisins on stem, add one pint vinegar and half pound sugar; simmer over a slow fire half an hour.

Strawberry Pickles.

Place strawberries in bottom of jar, add a layer of cinnamon and cloves, then berries, and so on; pour over it a syrup made of two coffee-cups cider vinegar, and three pints sugar, boiled about five minutes; let stand twenty-four hours, pour off syrup, boil, pour over berries, and let stand as before, then boil berries and syrup slowly for twenty-five minutes; put in jars and cover. The above is for six quarts of berries. Pine apples can be made in same way, allowing six and a half pounds of fruit to above proportions.

Green Tomato Pickle.

Take eight pounds of green tomatoes and chop fine, add four pounds brown sugar and boil down three hours, add a quart of vinegar, a teaspoon each of mace, cinnamon and cloves, and boil about fifteen minutes; let cool and put into jars or other vessels. Try this recipe once and you will try it again.

Ripe Tomato Pickle.

Pare and weigh ripe tomatoes and put into jars and just cover with vinegar; after standing three days pour off the vinegar and add five pounds coffee sugar to every seven of fruit; spice to taste and pour over tomatoes and cook slowly all day on the back of the stove. Use cinnamon, mace and a *little cloves* or not any, as preferred.

Watermelon Pickle.

Pare off very carefully the green part of the rind of a good, ripe watermelon; trim off the red core, cut in pieces one or two inches in length, place in a porcelain-lined kettle, in the proportion of one gallon rinds to two heaping tea-spoons common salt and water to nearly cover, boil until tender enough to pierce with a silver fork, pour into a colander to drain, and dry by taking a few pieces at a time in the hand, and pressing gently with a crash towel. Make syrup, and treat rinds exactly as directed for pickled peaches. Continue adding rinds, as melons are used at table, preparing them not by cooking in salt water as above; when as many are prepared as are wanted, and they are nearly pickled, drain and finish as directed in peach pickles, except when the syrup is boiled the last time, put in melons and boil fifteen minutes; set jar near stove, skim out melons and put in jar a few at a time, heating gradually so as not to break it, then pour in syrup boiling hot. A rind nearly an inch thick, crisp and tender, is best, although any may be used. If scum rises, and the syrup assumes a whitish appearance, drain, boil and skim syrup, add melons, and boil until syrup is like thin molasses.

Clover Vinegar.

Put a large bowl of molasses in a crock, and pour over it nine bowls of boiling rain-water; let stand until milk-warm, put in two quarts of clover blossoms, and two cups of baker's yeast; let this stand two weeks, and strain through a towel. Nothing will mold in it.—*Mrs. McAlister, Goshen, Ind.*

Mint Vinegar.

Put into a wide-mouthed bottle enough fresh, clean peppermint, spearmint, or garden parsley leaves to fill it loosely; fill up with good vinegar, stop closely, leave on for two or three weeks, pour off into another bottle, and keep well corked for use. This is excellent for cold meats, soups and bread-dressings for roasts; when mints can not be obtained, celery seed is used in the same way.

Spiced Vinegar.

Put three pounds sugar in a three gallon jar with a small mouth; mix two ounces each of mace, cloves, pepper, allspice, turmeric, celery seed, white ginger in small bits, and ground mustard; put in six small bags made of thin but strong muslin, lay in jar, fill with best cider vinegar, and use it in making pickles and sauces.

Tarragon Vinegar.

Gather the tarragon just before it blossoms, strip it from the larger stalks and put it into small stone jars or wide-necked bottle; and in doing this twist the branches, bruising the leaves. Pour over it vinegar enough to cover; let it stand two months or longer, pour off, strain, and put into small dry bottles, cork well and use as sauce for meats.

Cauliflower Pickles.

To twelve heads of cauliflower, five quarts of vinegar, five cups brown sugar, six eggs, one bottle French mustard, two tablespoonfuls ginger, a few garlic, two green peppers, one-half teaspoonful cayenne, butter size of an egg, one ounce pulverized turmeric. Beat well together the eggs, sugar, mustard, ginger, and turmeric, then boil in vinegar, with garlic and peppers, ten minutes. Boil cauliflower in salt water until tender, then place carefully in jar, pour over the boiling hot mixture.—*Mrs. W. W. Eastman, Minneapolis.*

Ripe Cucumber Pickles.

Take twenty-four large cucumbers, ripe and sound, six white onions, four large red peppers; pare and remove the seeds from the cucumbers, chop well, not too fine; then chop fine onions and peppers, mix thoroughly with one cup salt, one ounce white mustard; place in a muslin bag; drain twenty-four hours, remove to glass jars, cover with cold vinegar and seal. They will keep a long time and are excellent.—*Mrs. A. F. Conkey, Minneapolis, Minn.*

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Construction of a Simplified Wood Gas Generator for Fueling Internal Combustion Engines in a Petroleum Emergency

Final Report

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CONTENTS

EXECUTIVE SUMMARY

This report is one in a series of emergency technology assessments sponsored by the Federal Emergency Management Agency (FEMA). The purpose of this report is to develop detailed, illustrated instructions for the fabrication, installation, and operation of a biomass gasifier unit (i.e., a "producer gas" generator, also called a "wood gas" generator) which is capable of providing emergency fuel for vehicles, such as tractors and trucks, should normal petroleum sources be severely disrupted for an extended period of time. These instructions have been prepared as a manual for use by any mechanic who is reasonably proficient in metal fabrication or engine repair.

Fuel gas, produced by the reduction of coal and peat, was used for heating as early as 1840 in Europe and by 1884 had been adapted to fuel engines in England. Prior to 1940, gas generator units were a familiar, but not extensively utilized, technology. However, petroleum shortages during World War II led to widespread gas generator applications in the transportation industries of Western Europe. (Charcoal-burning taxis, a related application,

were still common in Korea as late as 1970.) The United States, never faced with such prolonged or severe oil shortages, has lagged far behind Europe and the Orient in familiarity with and application of this technology. However, a catastrophic event could disrupt the supply of petroleum in this country so severely that this technology might be critical in meeting the energy needs of some essential economic activities, such as the production and distribution of food.

In occupied Denmark during World War II, 95% of all mobile farm machinery, tractors, trucks, stationary engines, and fishing and ferry boats were powered by wood gas generator units. Even in neutral Sweden, 40% of all motor traffic operated on gas derived from wood or charcoal. All over Europe, Asia, and Australia, millions of gas generators were in operation between 1940 and 1946. Because of the wood gasifier's somewhat low efficiency, the inconvenience of operation, and the potential health risks from toxic fumes, most of such units were abandoned when oil again became available in 1945. Except for the technology of producing alternate fuels, such as methane or alcohol, the only solution for operating existing internal combustion engines, when oil and petroleum products are not available, has been these simple, inexpensive gasifier units.

This report attempts to preserve the knowledge about wood gasification that was put into practical use during World War II. In this report, detailed step-by-step procedures are presented for constructing a simplified version of the World War II wood gas generator; this simple, stratified, downdraft gasifier unit (shown schematically in Fig. S-1) can be constructed from materials which would be widely available in the United States in a prolonged petroleum crisis. For example, the body of the unit consists of a galvanized metal garbage can atop a small metal drum; common plumbing fittings are used throughout; and a large, stainless steel mixing bowl is used for the grate. A prototype gasifier unit was fabricated from these instructions (see Fig. S-2); this unit was then mounted onto the front of a farm tractor and successfully field tested, using wood chips as the only fuel (see Fig. S-3). Photographic documentation of the actual assembly of the unit, as well as its operational field test, is included in the body of this report.

The use of wood gas generators need not be limited to transportation applications. Stationary engines can also be fueled by wood gasifiers to run electric generators, pumps, and industrial equipment. In fact, the use of wood gas as a fuel is not even restricted to gasoline engines; if a small amount of diesel fuel is used for ignition, a properly adjusted diesel engine can be operated primarily on wood gas introduced through the intake manifold.

S.1. PRINCIPLES OF SOLID FUEL GASIFICATION

All internal combustion engines actually run on vapor, not liquid. The liquid fuels used by gasoline engines are vaporized before they enter the combustion chamber above the pistons. In diesel engines, the fuel is sprayed into the combustion chamber as fine droplets which burn as they vaporize. The purpose of a gasifier, then, is to transform solid fuels into gaseous ones and to keep the gas free of harmful constituents. A gas generator unit is simultaneously an energy converter and a filter. In these twin tasks lie its advantages and its difficulties.

In a sense, gasification is a form of incomplete combustion–heat from the burning solid fuel creates gases which are unable to burn completely because of the insufficient amounts of oxygen from the available supply of air. The same chemical laws which govern combustion processes also apply to gasification. There are many solid biomass fuels suitable for gasification–from wood and paper to peat, lignite, and coal, including coke derived from coal. All of these solid fuels are composed primarily of carbon with varying amounts of hydrogen, oxygen, and impurities, such as sulphur, ash, and moisture. Thus, the aim of gasification is the almost complete transformation of these constituents into gaseous form so that only the

ashes and inert materials remain. In creating wood gas for fueling internal combustion engines, it is important that the gas not only be properly produced, but also preserved and not consumed until it is introduced into the engine where it may be appropriately burned.

Gasification is a physiochemical process in which chemical transformations occur along with the conversion of energy. The chemical reactions and thermochemical conversions which occur inside a wood gas generator are too long and too complicated to be covered here; however, such knowledge is not necessary for constructing and operating a wood gasifier. By weight, gas (wood gas) produced in a gasifier unit contains approximately 20% hydrogen (H_2), 20% carbon monoxide (CO), and small amounts of methane, all of which are combustible, plus 50 to 60% nitrogen (N_2). The nitrogen is not combustible; however, it does occupy volume and dilutes the wood gas as it enters and burns in an engine. As the wood gas burns, the products of combustion are carbon dioxide (CO_2) and water vapor (H_2O).

One of the by-products of wood gasification is carbon monoxide, a poisonous gas. The toxic hazards associated with breathing this gas should be avoided during refueling operations or prolonged idling, particularly in inadequately ventilated areas. Except for the obvious fire hazard resulting from the combustion processes inside the unit, carbon monoxide poisoning is the major potential hazard during normal operation of these simplified gasifier units.

S.2. THE STRATIFIED, DOWNDRAFT GASIFIER

Until the early 1980s, wood gasifiers all over the world (including the World War II designs) operated on the principle that both the fuel hopper and the combustion unit be absolutely airtight; the hopper was sealed with a top or lid which had to be opened every time wood was added. Smoke and gas vented into the atmosphere while wood was being loaded; the operator had to be careful not to breathe the unpleasant smoke and toxic fumes.

Over the last few years, a new gasifier design has been developed through cooperative efforts among researchers at the Solar Energy Research Institute in Colorado, the University of California in Davis, the Open University in London, the Buck Rogers Company in Kansas, and the Biomass Energy Foundation, Inc., in Florida. This simplified design employs a balanced, negative-pressure concept in which the old type of sealed fuel hopper is no longer necessary. A closure is only used to preserve the fuel when the engine is stopped. This new technology has several popular names, including "stratified, downdraft gasification" and "open top gasification." Several years of laboratory and field testing have indicated that such simple, inexpensive gasifiers can be built from existing hardware and will perform very well as emergency units.

A schematic diagram of the stratified, downdraft gasifier is shown in Fig. S-1. During operation of this gasifier, air passes uniformly downward through four zones, hence the name "stratified:"

1. The uppermost zone contains unreacted fuel through which air and oxygen enter. This region serves the same function as the fuel hopper in the older, World War II designs.

2. In the second zone, the wood fuel reacts with oxygen during pyrolysis. Most of the volatile components of the fuel are burned in this zone and provide heat for continued pyrolysis reactions. At the bottom of this zone, all of the available oxygen from the air should be completely reacted. The open top design ensures uniform access of air to the pyrolysis region.

3. The third zone is made up of charcoal from the second zone. Hot combustion gases from the pyrolysis region react with the charcoal to convert the carbon dioxide and water vapor into carbon monoxide and hydrogen.

4. The inert char and ash, which constitute the fourth zone, are normally too cool to cause further reactions; however, because the fourth zone is available to absorb heat or oxygen as conditions change, it serves both as a buffer and as a charcoal storage region. Below this zone is the grate. The presence of char and ash serves to protect the grate from excessive temperatures.

The stratified, downdraft design has a number of advantages over the World War II gasifier designs. The open top permits fuel to be fed more easily and allows easy access. The cylindrical shape is easy to fabricate and permits continuous flow of fuel. No special fuel shape or pretreatment is necessary; any blocky fuel can be used.

The foremost question about the operation of the stratified, downdraft gasifier concerns char and ash removal. As the charcoal reacts with the combustion gases, it eventually reaches a very low density and breaks up into a dust containing all of the ash as well as a percentage of the original carbon. This dust may be partially carried away by the gas and might eventually begin to plug the gasifier. Hence, it must be removed by shaking or agitation. When the stratified gasifier unit is used to power vehicles, it is automatically shaken by the vehicle's motion.

An important issue in the design of the stratified, downdraft gasifier is the prevention of fuel bridging and channeling. High-grade biomass fuels, such as wood blocks or chips, will flow down through the gasifier because of gravity and downdraft air flow. However, other fuels (such as shredded chips, sawdust, and bark) can form a bridge, which will obstruct continuous flow and cause very high temperatures. Bridging can be prevented by stirring, shaking, or by agitating the grate or by having it agitated by the vehicle's movement. For prolonged idling, a hand operated shaker has been included in the design in this report.

A prototype unit of the stratified, downdraft gasifier design (see Figs. S-2 and S-3) has been fabricated according to the instructions in this report; however, it has not been widely tested at this time. The reader is urged to use his ingenuity and initiative in constructing his own wood gas generator. As long as the principle of airtightness in the combustion regions, in the connecting piping, and in the filter units is followed, the form, shape, and method of assembly is not important.

The wood gasifier design presented in this report has as its origin the proven technology used in World War II during actual shortages of gasoline and diesel fuel. It should be acknowledged that there are alternate technologies (such as methane production or use of alcohol fuels) for keeping internal combustion engines in operation during a prolonged petroleum crisis; the wood gasifier unit described in this report represents only one solution to the problem.

CONVERSION FACTORS FOR SI UNITS

English units have been retained in the body of this report. The report refers to commercially available materials and sizes which are commonly expressed in English units. The conversion factors for SI units are given below.

To convert from	To	Multiply by
cubic feet (ft^3)	cubic meters (m^3)	0.0283
cubic yards (yd^3)	cubic meters (m^3)	0.7646
Fahrenheit degrees (°F)	Kelvin degrees (°K)	(see Note 1)
foot (ft)	meter (m)	0.3048

gallon (gal)	cubic meters (m^3)	3.785×10^{-3}
horsepower (hp)	watt (W)	745.7
inch (in.)	meter (m)	0.0254
pound (lb)	kilogram (kg)	0.4536
quart (qt.)	cubic meters (m^3)	9.464×10^{-4}

Note 1: To convert temperatures, use the following equation,

$$K = 273 + 0.5556 \times (F - 32) \ ,$$

where

F is the temperature in Fahrenheit degrees, and

K is the temperature in Kelvin degrees.

LIST OF FIGURES

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1. WHAT IS A WOOD GAS GENERATOR AND HOW DOES IT WORK?

This report is one in a series of emergency technology assessments sponsored by the Federal Emergency Management Agency (FEMA). The purpose of this report is to develop detailed, illustrated instructions for the fabrication, installation, and operation of a biomass gasifier unit (i.e., a "producer gas" generator, also called a "wood gas" generator) that is capable of providing emergency fuel for vehicles, such as tractors and trucks, in the event that normal petroleum sources were severely disrupted for an extended period of time. These instructions have been prepared as a manual for use by any mechanic who is reasonably proficient in metal fabrication or engine repair.

1.1 INTRODUCTION

Fuel gas, produced by the reduction of coal and peat, was used for heating, as early as 1840 in Europe, and by 1884 it had been adapted to fuel engines in England. Before 1940, gas generator units were a familiar, but not extensively utilized, technology. However, petroleum shortages during World War II led to widespread gas generator applications in the transportation industries of Western Europe. (Charcoal-burning taxis, a related application, were still common in Korea as late as 1970.) The United States, never faced with such pro-

longed or severe oil shortages, has lagged far behind Europe and the Orient in familiarity with and application of this technology; however, a catastrophe could so severely disrupt the supply of petroleum in this country that this technology might be critical in meeting the energy needs of some essential economic activities, such as the production and distribution of food.

This report attempts to preserve the knowledge about wood gasification as put into practical use during World War II. Detailed, step-by-step procedures are presented in this report for constructing a simplified version of the World War II, Imbert wood gas generator. This simple, stratified, downdraft gasifier unit can be constructed from materials that would be widely available in the United States in a prolonged petroleum crisis. For example, the body of the unit consists of a galvanized metal garbage can atop a small metal drum; common plumbing fittings throughout; and a large, stainless steel mixing bowl for the grate. A prototype gasifier unit was fabricated from these instructions. This unit was then mounted onto the front of a gasoline-engine farm tractor and successfully field tested, using wood chips as the only fuel; see Fig. 1-1 (all figures and tables are presented at the end of their respective sections). Photographic documentation of the actual assembly of the unit, as well as its operational field test, is included in this report.

The use of wood gas generators need not be limited to transportation applications. Stationary engines can also be fueled by wood gasifiers to run electric generators, pumps, and industrial equipment. In fact, the use of wood gas as a fuel is not even restricted to gasoline engines; if a small amount of diesel fuel is used for ignition, a properly adjusted diesel engine can be operated primarily on wood gas introduced through the intake manifold. However, this report is concerned with the operation of four-cycle gasoline engines rated from 10 to 150 horsepower. If more information is needed about operating gasifiers on other fuels (such as coal, charcoal, peat, sawdust or seaweed), a list of relevant literature is contained in the Bibliography at the end of this report.

The goal of this report is to furnish information for building a homemade wood gas generator made out of ordinary, available hardware, in order to get tractors, trucks, and other vehicles operating without delay, if a severe liquid fuel emergency should arise. Section 1 describes gasification principles and wood gas generators, in general, and gives some historical background about their operation and effectiveness. Section 2 contains detailed step-by-step instructions for constructing your own wood gas generator unit; illustrations and photographs are included to prevent confusion. Section 3 contains information on operating, maintaining, and trouble-shooting your wood gas generator; also included are some very important guidelines on safety when using your gasifier system.

The wood gasifier design presented in this report has as its origin the proven technology used in World War II during actual shortages of gasoline and diesel fuel. It should be acknowledged that there are alternate technologies (such as methane production or use of alcohol fuels) for keeping internal combustion engines in operation during a prolonged petroleum crisis; the wood gasifier unit described in this report represents only one solution to the problem.

1.2 PRINCIPLES OF SOLID FUEL GASIFICATION

All internal combustion engines actually run on vapor, not liquid. The liquid fuels used in gasoline engines are vaporized before they enter the combustion chamber above the pistons. In diesel engines, the fuel is sprayed into the combustion chamber as fine droplets which burn as they vaporize. The purpose of a gasifier, then, is to transform solid fuels into gaseous ones and to keep the gas free of harmful constituents. A gas generator unit is, simultaneously, an energy converter and a filter. In these twin tasks lie its advantages and its difficulties.

The first question many people ask about gasifiers is, "Where does the combustible gas

come from?" Light a wooden match; hold it in a horizontal position; and notice that while the wood becomes charcoal, it is not actually burning but is releasing a gas that begins to burn brightly a short distance away from the matchstick. Notice the gap between the matchstick and the luminous flame; this gap contains the wood gas which starts burning only when properly mixed with air (which contains oxygen). By weight, this gas (wood gas) from the charring wood contains approximately 20% hydrogen (H_2), 20% carbon monoxide (CO), and small amounts of methane, all of which are combustible, plus 50 to 60% nitrogen (N_2). The nitrogen is not combustible; however, it does occupy volume and dilutes the wood gas as it enters and burns in an engine. As the wood gas burns, the products of combustion are carbon dioxide (CO_2) and water vapor (H_2O).

The same chemical laws which govern combustion processes also apply to gasification. The solid, biomass fuels suitable for gasification cover a wide range, from wood and paper to peat, lignite, and coal, including coke derived from coal. All of these solid fuels are composed primarily of carbon with varying amounts of hydrogen, oxygen, and impurities, such as sulphur, ash, and moisture. Thus, the aim of gasification is the almost complete transformation of these constituents into gaseous form so that only the ashes and inert materials remain.

In a sense, gasification is a form of incomplete combustion; heat from the burning solid fuel creates gases which are unable to burn completely, due to insufficient amounts of oxygen from the available supply of air. In the matchstick example above, as the wood was burned and pyrolyzed into charcoal, wood gas was created, but the gas was also consumed by combustion (since there was an enormous supply of air in the room). In creating wood gas for fueling internal combustion engines, it is important that the gas not only be properly produced, but also preserved and not consumed until it is introduced into the engine where it may be appropriately burned.

Gasification is a physiochemical process in which chemical transformations occur along with the conversion of energy. The chemical reactions and thermochemical conversions which occur inside a wood gas generator are too long and too complicated to be covered here. Such knowledge is not necessary for constructing and operating a wood gasifier. Books with such information are listed in the Reference Section (see, for example, Reed 1979, Vol. II; or Reed and Das 1988).

1.3 BACKGROUND INFORMATION

The use of wood to provide heat is as old as mankind; but by burning the wood we only utilize about one-third of its energy. Two-thirds is lost into the environment with the smoke. Gasification is a method of collecting the smoke and its combustible components. Making a combustible gas from coal and wood began around 1790 in Europe. Such manufactured gas was used for street lights and was piped into houses for heating, lighting, and cooking. Factories used it for steam boilers, and farmers operated their machinery on wood gas and coal gas. After the discovery of large petroleum reserves in Pennsylvania in 1859, the entire world changed to oil-a cheaper and more convenient fuel. Thousands of gas works all over the world were eventually dismantled.

Wood gas generators are not technological marvels that can totally eliminate our current dependence on oil, reduce the impacts of an energy crunch, or produce long-term economic relief from high fossil fuel prices, but they are a proven emergency solution when such fuels become unobtainable in case of war, civil upheaval, or natural disaster. In fact, many people can recall a widespread use of wood gas generators during World War II, when petroleum products were not available for the civilian populations in many countries. Naturally, the people most affected by oil and petroleum scarcity made the greatest advancements in wood gas generator technology.

In occupied Denmark during World War II, 95% of all mobile farm machinery,

tractors, trucks, stationary engines, fishing and ferry boats were powered by wood gas generators. Even in neutral Sweden, 40% of all motor traffic operated on gas derived from wood or charcoal (Reed and Jantzen 1979). All over Europe, Asia, and Australia, millions of gas generators were in operation between 1940 and 1946. Because of the wood gasifier's somewhat low efficiency, the inconvenience of operation, and the potential health risks from toxic fumes, most of such units were abandoned when oil again became available in 1945. Except for the technology of producing alternate fuels, such as methane or alcohol, the only solution for operating existing internal combustion engines, when oil and petroleum products are not available, has been these simple, inexpensive gasifier units.

1.3.1 The World War II, Imbert Gasifier

The basic operation of two gasifiers is described in this and the following section. Their operating advantages and disadvantages will also be discussed. This information is included for the technically interested reader only; it is intended to give the reader more insight into the subtleties of the operating principles of the wood gas generator described in this manual. Those readers who are anxious to begin construction of their own wood gas generator may skip the material below and proceed directly to Sect. 2 without any loss of continuity.

The constricted hearth, downdraft gasifier shown in Fig. 1-2 is sometimes called the "Imbert" gasifier after its inventor, Jacques Imbert; although, it has been commercially manufactured under various names. Such units were mass produced during World War II by many European automotive companies, including General Motors, Ford, and Mercedes-Benz. These units cost about $1500 (1985 evaluation) each. However, after World War II began in 1939, it took six to eight months before factory-made gasifiers were generally available. Thousands of Europeans were saved from certain starvation by home-built, simple gasifier units made from washing machine tubs, old water heaters, and metal gas or oxygen cylinders. Surprisingly, the operation of these units was nearly as efficient as the factory-made units; however, the homemade units lasted for only about 20,000 miles with many repairs, while the factory-made units operated, with few repairs, up to 100,000 miles.

In Fig. 1-2, the upper cylindrical portion of the gasifier unit is simply a storage bin or hopper for wood chips or other biomass fuel. During operation, this chamber is filled every few hours as needed. The spring-loaded, airtight cover must be opened to refill the fuel hopper; it must remain closed and sealed during gasifier operation. The spring permits the cover to function as a safety valve because it will pop open in case of any excessive internal gas pressure.

About one third of the way up from the bottom of the gasifier unit, there is a set of radially directed air nozzles; these allow air to be injected into the wood as it moves downward to be gasified. In a gas generator for vehicle use, the downstroke of the engine's pistons creates the suction force which moves the air into and through the gasifier unit; during startup of the gasifier, a blower is used to create the proper airflow. The gas is introduced into the engine and consumed a few seconds after it is made. This gasification method is called "producer gas generation," because no storage system is used; only that amount of gas demanded by the engine is produced. When the engine is shut off, the production of gas stops.

During normal operation, the incoming air burns and pyrolyzes some of the wood, most of the tars and oils, and some of the charcoal that fills the constricted area below the nozzles. Most of the fuel mass is converted to gas within this combustion zone. The Imbert gasifier is, in many ways, self-adjusting. If there is insufficient charcoal at the air nozzles, more wood is burned and pyrolyzed to make more charcoal. If too much charcoal forms, then the charcoal level rises above the nozzles, and the incoming air burns the charcoal. Thus, the combustion zone is maintained very close to the nozzles.

Below this combustion zone, the resulting hot combustion gases–carbon dioxide (CO_2) and water vapor (H_2O)–pass into the hot charcoal where they are chemically reduced to combustible fuel gases: carbon monoxide (CO) and hydrogen (H_2). The hearth constriction causes all gases to pass through the reaction zone, thus giving maximum mixing and minimum heat loss. The highest temperatures are reached in this region.

Fine char and ash dust can eventually clog the charcoal bed and will reduce the gas flow unless the dust is removed. The charcoal is supported by a movable grate which can be shaken at intervals. Ash buildup below the grate can be removed during cleaning operations. Usually, wood contains less than 1% ash (by weight). However, as the charcoal is consumed, it eventually collapses to form a powdery charcoal/ash mixture which may represent 2 to 10% (by weight) of the total fuel mass.

The cooling unit required for the Imbert gasifier consists of a water-filled precipitating tank and an automotive radiator-type gas cooler. The precipitating tank removes all unacceptable tars and most of the fine ash from the gas flow, while the radiator further cools the gas. A second filter unit, containing a fine-mesh filtration material, is used to remove the last traces of any ash or dust that may have survived passage through the cooling unit. Once out of the filter unit, the wood gas is mixed with air in the vehicle's carburetor and is then introduced directly into the engine's intake manifold.

The World War II, Imbert gasifier requires wood with a low moisture content (less than 20% by weight) and a uniform, blocky fuel in order to allow easy gravity feed through the constricted hearth. Twigs, sticks, and bark shreds cannot be used. The constriction at the hearth and the protruding air nozzles present obstructions to the passage of the fuel and may create bridging and channeling followed by poor quality gas output, as unpyrolyzed fuel falls into the reaction zone. The vehicle units of the World War II era had ample vibration to jar the carefully sized wood blocks through the gasifier. In fact, an entire industry emerged for preparing wood for use in vehicles at that time (Reed and Jantzen 1979). However, the constricted hearth design seriously limits the range of wood fuel shapes that can be successfully gasified without expensive cubing or pelletizing pretreatment. It is this limitation that makes the Imbert gasifier less flexible for emergency use.

In summary, the World War II Imbert gasifier design has stood the test of time and has successfully been mass produced. It is relatively inexpensive, uses simple construction materials, is easy to fabricate, and can be operated by motorists with a minimum amount of training.

1.3.2 The Stratified, Downdraft Gasifier

Until the early 1980s, wood gasifiers all over the world (including the World War II designs) operated on the principle that both the fuel hopper and the combustion unit be airtight; the hopper was sealed with a top or lid that had to be opened every time wood was added. Smoke and gas vented into the atmosphere while new wood was being loaded; the operator had to be careful not to breathe the unpleasant smoke and toxic fumes.

Over the last few years, a new gasifier design has been developed through cooperative efforts among researchers at the Solar Energy Research Institute in Colorado, the University of California in Davis, the Open University in London, the Buck Rogers Company in Kansas, and the Biomass Energy Foundation, Inc., in Florida (Reed and Das 1988). This simplified design employs a balanced, negative-pressure concept in which the old type of sealed fuel hopper is no longer necessary. A closure is only used to preserve the fuel when the engine is stopped. This new technology has several popular names, including "stratified, downdraft gasification" and "open top gasification." Two years of laboratory and field testing have indicated that such simple, inexpensive gasifiers can be built from existing hardware and will perform very well as emergency units.

A schematic diagram of the stratified, downdraft gasifier is shown in Fig. 1-3. During

operation of this gasifier, air passes uniformly downward through four zones, hence the name "stratified:"

1. The uppermost zone contains unreacted fuel through which air and oxygen enter. This region serves the same function as the fuel hopper in the Imbert design.

2. In the second zone, the wood fuel reacts with oxygen during pyrolysis. Most of the volatile components of the fuel are burned in this zone and provide heat for continued pyrolysis reactions. At the bottom of this zone, all of the available oxygen from the air has completely reacted. The open top design ensures uniform access of air to the pyrolysis region.

3. The third zone is made up of charcoal from the second zone. Hot combustion gases from the pyrolysis region react with the charcoal to convert the carbon dioxide and water vapor into carbon monoxide and hydrogen.

4. The inert char and ash, which constitute the fourth zone, are normally too cool to cause further reactions; however, since the fourth zone is available to absorb heat or oxygen as conditions change, it serves both as a buffer and as a charcoal storage region. Below this zone is the grate. The presence of char and ash serves to protect the grate from excessive temperatures.

The stratified, downdraft design has a number of advantages over the World War II, Imbert gasifier. The open top permits fuel to be fed more easily and allows easy access. The cylindrical shape is easy to fabricate and permits continuous flow of fuel. No special fuel shape or pretreatment is necessary; any blocky fuel can be used.

The foremost question about the operation of the stratified, downdraft gasifier concerns char and ash removal. As the charcoal reacts with the combustion gases, it eventually reaches a very low density and breaks up into a dust containing all of the ash as well as a percentage of the original carbon. This dust may be partially carried away by the gas; however, it might eventually begin to plug the gasifier, and so it must be removed by shaking or agitation. Both the Imbert gasifiers and the stratified concept have a provision for shaking the grate; when they are used to power vehicles, they are automatically shaken by the vehicle's motion.

An important issue in the design of the stratified, downdraft gasifier is the prevention of fuel bridging and channeling. High-grade biomass fuels such as wood blocks or chips will flow down through the gasifier under the influence of gravity, and downdraft air flow. However, other fuels (such as shredded wood, sawdust, and bark) can form a bridge that will prevent continuous flow and cause very high temperatures. Obviously, it is desirable to use these widely available biomass residues. Bridging can be prevented by stirring, shaking, or by agitating the grate or by having it agitated by the vehicle's movement. For prolonged idling, a hand-operated shaker has been included in the design.

A prototype design of the stratified, downdraft gasifier design has been developed. The detailed but simple design is described and illustrated in Sect. 2; however, it has not been widely tested at this time. The reader is urged to use his ingenuity and initiative in constructing his own wood gas generator. As long as the principle of airtightness in the combustion regions, in the connecting piping, and in the filter units is followed, the form, shape, and method of assembly is not important.

2. BUILDING YOUR OWN WOOD GAS GENERATOR

The following fabrication instructions, parts lists, and illustrations describe the prototype gasifier unit shown schematically in Fig. 1-3. These instructions are simple and easy to follow. The dimensions in the following plans are given in inches rather than in millimeters to make

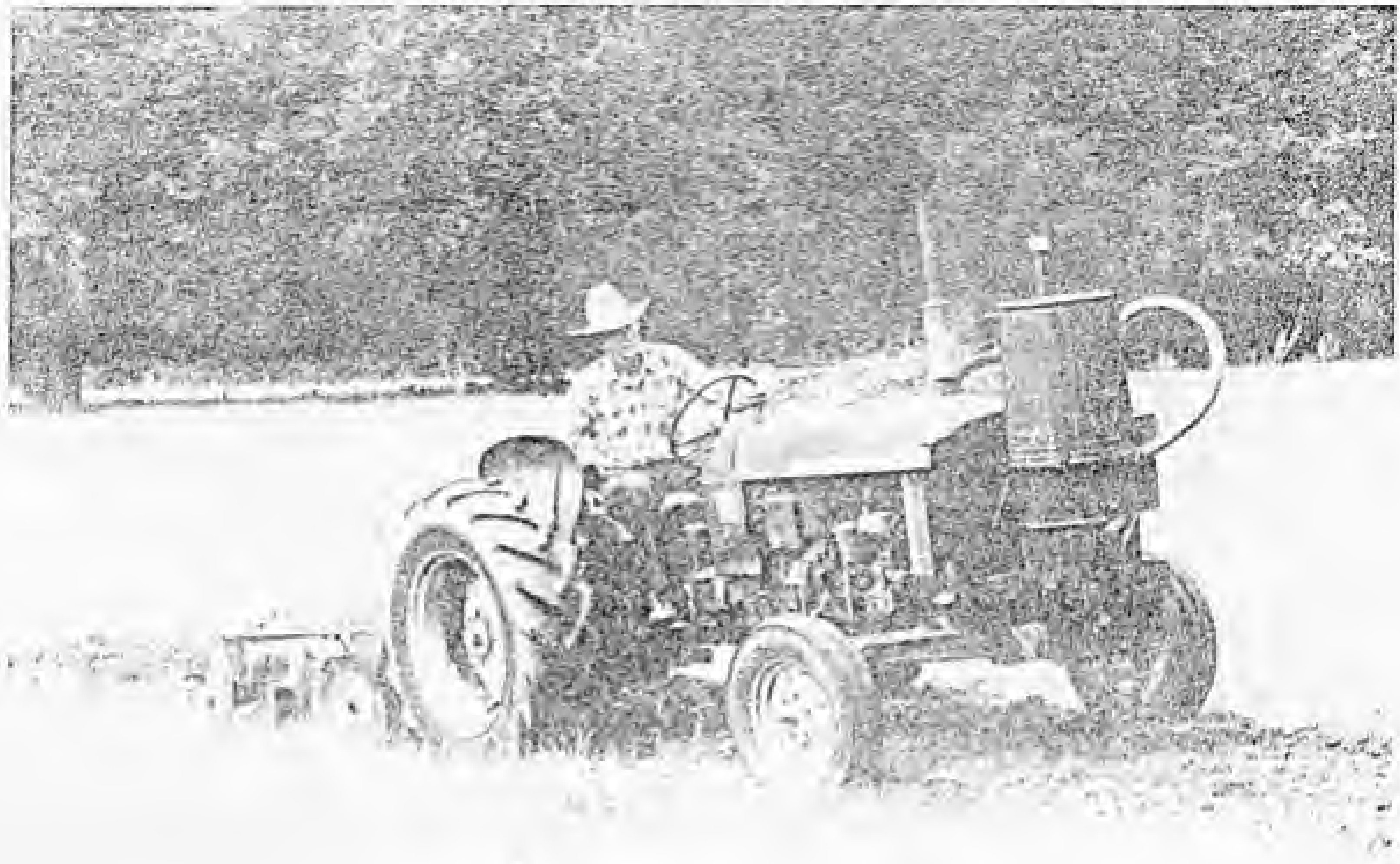


Fig. 1-1. Wood gas generator unit in operation during field testing.

construction easier for those who might be unfamiliar with the metric system and to allow the builder to take advantage of available, alternate construction materials. It will be obvious to the experienced engineer, mechanic, or builder that most of the dimensions (for example, plate thicknesses and cleanout diameters) are not critical to the acceptable performance of the finished gasifier unit.

The prototype gasifier unit described in the following text was actually constructed and field tested on a gasoline-engine farm tractor (a 35-hp, John Deere 1010 Special); see Fig. 2-1. The unit operated very well, and on par with the European, World War II designs, but it has not had the test of time nor the millions of operating hours like the older Imbert design. This new stratified design was developed for the construction of simple, inexpensive emergency wood gas generator units. The prototype design below should be considered to be the absolute minimum in regard to materials, piping and filter arrangement, and carburetor system connections.

The gasifier unit, as described below, is designed to maintain proper cooling, even at moderate vehicle speeds. If this unit is to be used on stationary engines or on slow-moving vehicles, a gas cooler and a secondary filter must be placed in the piping system between the generator unit and the carburetor. The ideal temperature for the wood gas at the inlet to the carburetor manifold would be 70°F, with acceptable peaks of 140 to 160°F. For every 10 degrees above 70°F, an estimated 1% horsepower is lost. Cooler gas has higher density and, therefore, contains more combustible components per unit volume.

The millions of wood gasifiers built during World War II proved that shape, form, and construction material had little or no effect on the performance of the unit. Judicious substitution or the use of scavenged parts is, therefore, quite acceptable. What is important is that:

1. the fire tube dimensions (inside diameter and length) must be correctly selected to

match the rated horsepower of particular engine which is to be fueled,

2. airtightness of the gas generator unit and all connecting piping must be maintained at all times, and

3. unnecessary friction should be eliminated in all of the air and gas passages by avoiding sharp bends in the piping and by using piping sizes which are not too small.

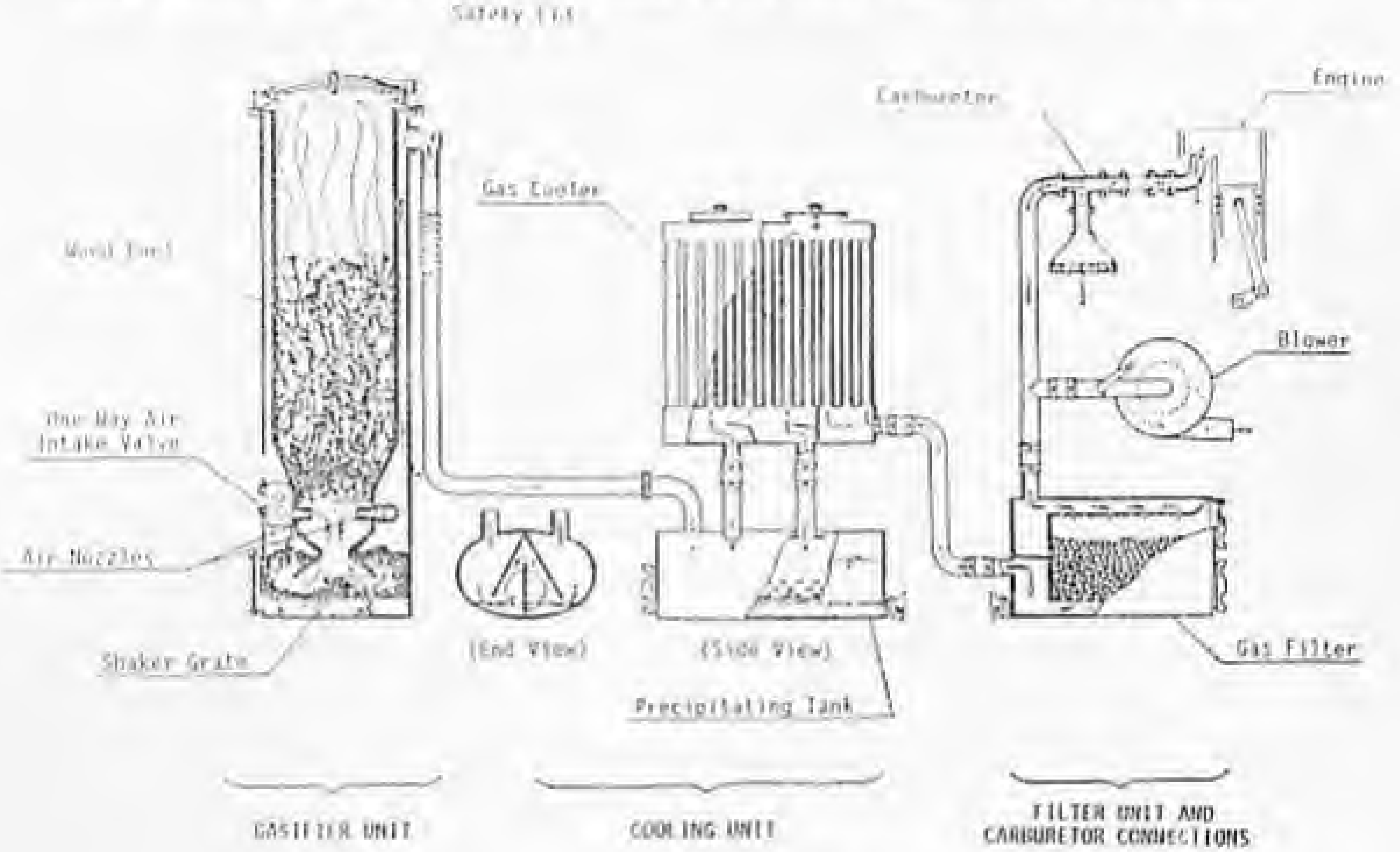


Fig. 1-2. Schematic view of the World War II, Imbert gasifier.

2.1. BUILDING THE GAS GENERATOR UNIT AND THE FUEL HOPPER

Figure 2-2 shows an exploded view of the gas generator unit and the fuel hopper; the list of materials is given in Table 2-1 (all figures and tables mentioned in Sect. 2 are presented at the end of Sect. 2). Only the dimensions of the fire tube (Item 1A) must be reasonably close; all other dimensions and materials can be substituted as long as complete airtightness is maintained. In the following instructions, all item numbers refer both to Fig. 2-2 and to Table 2-1.

The prototype unit described in this report was constructed for use with a 35-hp gasoline engine; the unit has a fire tube diameter of 6 in. (as determined from Table 2-2). A gas generator unit containing a fire tube up to 9-in. diameter (i.e., a gasifier unit for fueling engines up to about 65 hp) can be constructed from the following instructions. If your engine requires a fire tube diameter of 10 in. or more, use a 55-gal drum for the gas unit and another 55-gal drum for the fuel hopper.

The following fabrication procedure is very general and can be applied to the construction of gas generator units of any size; however, the specific dimensions which are given in the parts list and in the instructions below are for this particular prototype unit. All accompanying photographs were taken during the actual assembly of the prototype unit.

The fabrication procedure is as follows:

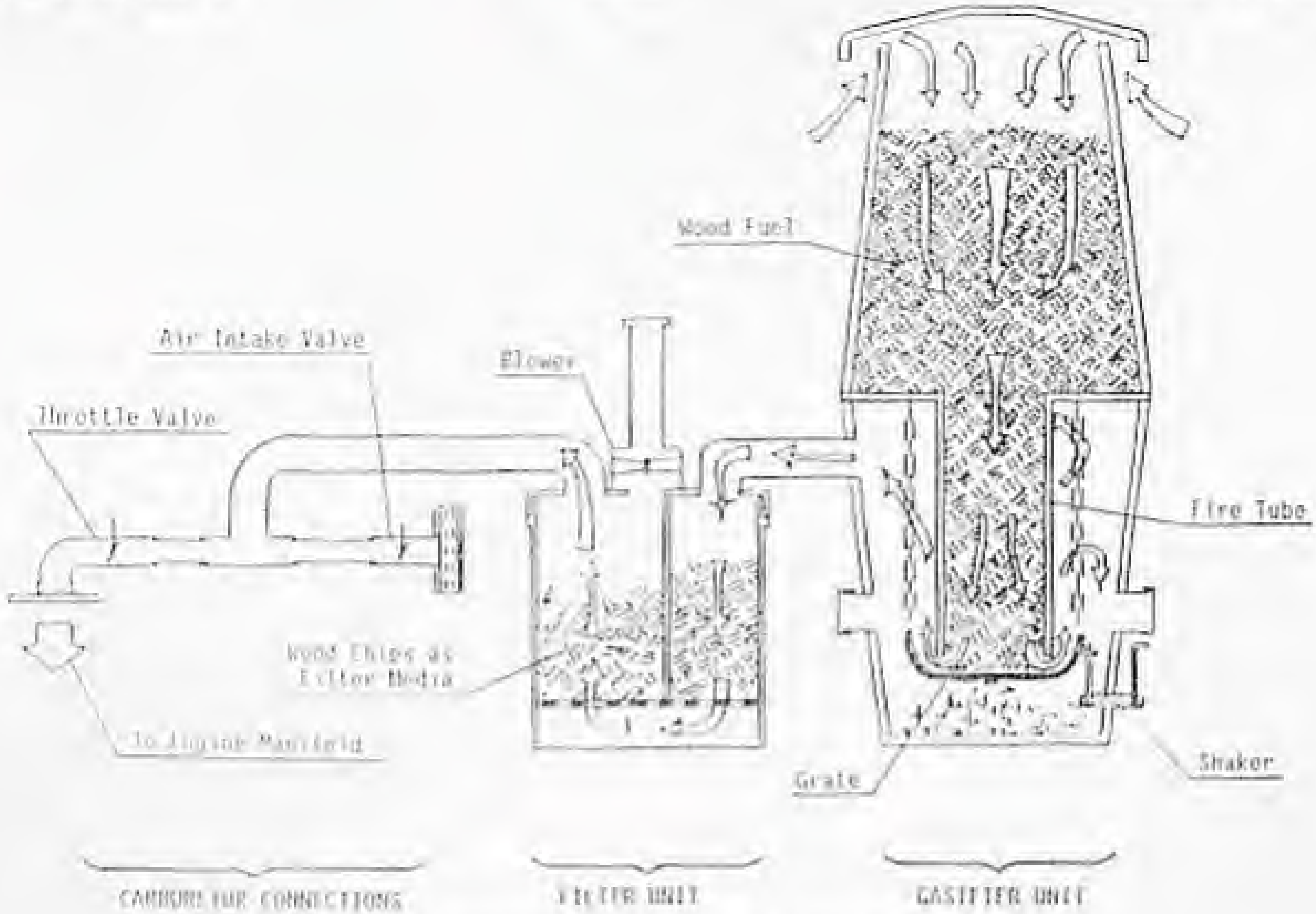


Fig. 1-3. Schematic view of the stratified, downdraft gasifier.

1. Using the displacement or horsepower rating of the engine to be fueled by the gasifier unit, determine the dimensions (inside diameter and length) of the fire tube (Item 1A) from Table 2-2. Fabricate a cylindrical tube or cut a length of correctly sized pipe to match the dimensions from Table 2-2. (For the prototype gasifier unit illustrated in this report, a 6-in.-diam firetube was used; its length was 19 in.)

2. The circular top plate (Item 2A) should be cut to a diameter equal to the outside diameter of the gasifier housing drum (Item 3A) at its top. A circular hole should then be cut in the center of the top plate; the diameter of this hole must be equal to the outside diameter of the fire tube. The fire tube (Item 1A) should then be welded at a right angle to the top plate (Item 2A) as shown in Fig. 2-3.

3. The grate (Item 4A) should be made from a stainless steel mixing bowl or colander. Approximately 125 holes with diameters of 1/2 in. should be drilled in the bottom and up the sides of the mixing bowl; see Fig. 2-4. A U-bolt (Item 5A) should be welded horizontally to the side of the grate, 2 in. from its bottom. This U-bolt will be interlocked with the shaker mechanism (Item 12A) in a later step.

4. The support chains (Item 6A) are to be attached to the grate in three evenly spaced holes drilled under the lip of the mixing bowl or colander; see Fig. 2-5. These chains are to be connected to the top plate (Item 2A) with eyebolts (Item 7A), as shown in Fig. 2-6. Each eyebolt should have two nuts, one on each side of the top plate, so that the eyebolts can be adjusted to the proper length. When assembled, the bottom of the firetube should be 1.25 in. above the bottom of the mixing bowl.

5. A hole equal to the outside diameter of the ash cleanout port (Item 8A) should be cut into the side of the gasifier housing drum (Item 3A); the bottom edge of this hole should be about 1/2 in. from the bottom of the drum. Because of the thin wall thickness of oil drums and garbage cans, welding is not recommended; brazing such parts to the drums or cans will ensure both strength and airtightness (see Fig. 2-7).

6. Two holes, equal to the outside diameters of the ignition ports (Item 10A), are to be cut with their centers at a distance from the top of the housing drum (Item 3A) equal to the firetube length less 7 in. (19 in. less 7 in. equals 12 in. for this prototype unit); the holes should be placed opposite each other as shown in Fig. 2-2. The ignition ports should be attached to the wall of the housing drum by brazing.

7. When the ash cleanout port (Item 8A) and the ignition ports (Item 10A) have been attached to the wall of the gasifier housing drum (Item 3A), they should then be closed with pipe caps, Items 9A and 11A respectively. The threads of the pipe caps should be first coated with high temperature silicone (Item 27A) to ensure airtightness. An optional steel crossbar welded to the pipe cap will reduce the effort required to open these caps later.

8. The shaker assembly (Item 12A) is shown in Fig. 2-8. The 1/2-in. pipe (Item 1AA) should be brazed into the side of the housing drum (Item 3A), 1.5 inches from the bottom of the drum; the length of this pipe which protrudes into the drum must be chosen so that the upright bar (Item 2AA) is in line with the U-bolt (Item 5A) on the grate. Likewise, the length of the upright bar must be selected so as to connect into the U-bolt.

9. Weld the upright bar (Item 2AA) to the head of the bolt (Item 3AA). The threaded end of the bolt should be ground down or flattened on one side, as shown in Fig. 2-9, to positively interlock with a slot to be drilled and filed in the handle (Item 4AA). The handle can be formed or bent into any desired or convenient shape.

10. A hole should be drilled in the pipe cap (Item 7AA) so that there is a close fit between this hole and the bolt (Item 3AA). The close fit will help to ensure airtightness.

11. Before assembling the shaker, as shown in Fig. 2-8, coat the bolt (Item 3AA) with a small amount of grease. Before inserting the bolt, fill the pipe (Item 1AA) with high temperature silicone (Item 27A) to ensure airtightness. Tighten the nuts (Item 6AA) so that the position of the handle (Item 4AA) is maintained by friction, yet is capable of being turned and agitated during cleanout or stationary operation.

12. Fabricate the supports (Item 13A) for the gasifier unit housing drum (Item 3A) out of rectangular, iron bar stock. The shape and height of the support flanges must be determined by the frame of the vehicle to which the gasifier is to be mounted. The supports can either be bolted to the bottom and side with the 1/4 in. bolts (Item 14A) or can be brazed directly to the drum; see Fig. 2-10. Remember to seal all bolt holes for airtightness.

13. Completely cover the bottom of the housing drum (Item 3A) with 1/2 in. of hydraulic cement (Item 28A). The cement should also be applied to the inside of the drum for

about 5 in. up the inside walls near the bottom. All edges should be rounded for easy ash removal.

14. The fuel hopper (Item 15A) is to be made from a second container with its bottom up as shown in Fig. 2-11. Remove the bottom, leaving a 1/4-in. lip around the circumference.

15. A garden hose (Item 17A) should be cut to a length equal to the circumference of the fuel hopper (Item 15A) and should then be slit along its entire length. It should be placed over the edge of the fuel hopper from which the bottom was removed. This will prevent injury to the operator when adding wood fuel to the unit. To insure close fit of the garbage can lid (Item 16A), a piece of weather stripping (Item 18A) should be attached under the lid where it makes contact with the fuel hopper.

16. Cut four support bars (Item 19A) to lengths 2.5 in. longer than the height of the fuel hopper (Item 15A). Drill a 3/8-in. hole in each end of all four support bars; these holes should be centered 3/4 in. from the ends. Bend 2 in. of each end of these support bars over at a right angle; then, mount them evenly spaced around the fuel hopper (Item 15A) with 1/4-in. bolts (Item 20A). One of the bends on each support bar should be as close to the lower edge of the fuel hopper as possible.

17. Cut four metal triangular standoffs (Item 21A) and braze, weld, or rivet them flat against the edge of the garbage can lid (Item 16A) as shown in Fig. 2-12; they must be aligned with the four support bars (Item 19A) attached to the fuel hopper. During operation, the garbage can lid must have a minimum 3/4-in. opening for air passage; the standoffs should provide this clearance when they are engaged into the holes in the top edges of the support bars (Item 19A); see Fig. 2-13.

18. Two eye hooks (Item 22A) should be attached to opposite sides of the garbage can lid (Item 16A). Two screen door springs (Item 23A) should be attached to the garbage can handles and used under tension to keep the top lid (Item 16A) either open or closed.

19. Cut the oil drum lock ring (Item 24A) to the exact circumference of the top plate (Item 2A) so that it will fit snugly around the gasifier unit housing drum (Item 3A).

20. Cut four 2 by 2 by 1/4-in. tabs (Item 25A); then, braze these tabs to the lock ring (Item 24A), evenly spaced and in alignment with the support bars (Item 19A) on the fuel hopper. Drill a 3/8-in. hole in each tab to align with the holes in the fuel hopper support bars (Item 19A). The lock ring is shown in Fig. 2-14.

21. The connecting pipe (Item 29A) between the gasifier unit and the filter unit should be attached to the gasifier housing drum (Item 3A) at a point 6 in. below the top of the drum. This pipe must be a minimum of 2-in. in diameter and should be at least 6 ft long for cooling purposes. At least one of the ends of this pipe must be removable for cleaning and maintenance. On this prototype unit, an airtight electrical conduit connector was used; this connection is visible in Fig. 2-1. Many similar plumbing devices are available and can be used if they are suitable for operation at 400°F and above. The pipe can also be welded or brazed directly to the housing drum.

22. When assembling the gasifier unit, the upright bar (Item 2AA) on the shaker assembly

must be placed inside the U-bolt (Item 5A) on the grate.

23. The lock ring will then clamp the gasifier unit housing drum (Item 3A) and the top plate (Item 2A) together. The fuel hopper support bars (Item 19A) must be attached to the tabs (Item 25A) on the lock ring with bolts (Item 26A). High temperature silicone (Item 27A) should be applied to all edges to make an airtight connection. The lock ring connections are shown in the lower portion of Fig. 2-13.

2.2 BUILDING THE PRIMARY FILTER UNIT

Figures 2-15 and 2-16 show exploded views of the primary filter unit; the list of materials is given in Table 2-3 (all figures and tables mentioned in Sect. 2 are presented at the end of Sect. 2). In the following instructions, all item numbers refer to either Fig. 2-15 or 2-16 and to Table 2-3.

The prototype primary filter unit was made from a 5-gal paint can. That size seems to be sufficient for gasifiers with fire tubes up to 10 in. in diameter. If a fire tube diameter of more than 10 in. is required, then a 20-gal garbage can or a 30-gal oil drum should be used. The filter unit could be fabricated in any shape or form as long as airtightness and unobstructed flow of gas are provided. If a 5-gal container is used, it must be clean and free of any chemical residue. The top edge must be straight and without any indentations. If an alternate container can be found or fabricated, a larger diameter will permit longer operation between cleanings.

The piping (Item 29A in Figs. 2-2 and 2-15) which connects the gas generator unit to the primary filter should be considered to be a necessary part of the cooling system and should never have an inside diameter less than 2 in. A flexible automotive exhaust pipe was used on the prototype filter unit described below; it was shaped into a semicircular arc so that increased length would achieve a greater cooling effect.

The fabrication procedure for the filter unit follows:

1. A hole equal to the outside diameter of the drain tube (Item 13B in Fig. 2-15) should be cut into the side of the filter container (Item 1B); the bottom edge of this hole should be about 1/2 in. from the inside bottom of the container.

2. The drain tube (Item 13B) should be inserted into the previously cut hole in the filter container and should be positioned so that its nonthreaded end is near the center of the container and is about 1/2 in. off the bottom. Once this position has been ensured, braze (do not weld) the drain pipe into the side of the filter container. Close the threaded, exterior end of the drain pipe with the pipe cap (Item 14B).

3. Coat the bottom of the filter container (Item 1B) with a 1/2-in. layer of hydraulic cement (Item 28A), taking care not to plug or obstruct the end of the drain tube (Item 13B) with cement (i.e., fill the drain tube with a paper, styrofoam, or other easily removable, but rigid material). The cement should also be applied for about 1.5 in. up the inside walls of the container near its bottom. Round the edges slightly; the cement is to provide a pathway for any liquid condensate to drain out through the drain tube. The cement must be allowed to harden before proceeding with the fabrication steps below. Remove the filler material from the drain tube when the cement has hardened.

4. A circular bottom plate (Item 2B) should be cut to a diameter 1/2 in. smaller than the inside diameter of the filter container (Item 1B). This will allow for heat expansion and easy removal for cleaning. This bottom plate should be drilled with as many 3/4-in.

holes as are practical for the size of the plate. Three evenly spaced 3/8-in. holes should also be drilled around the edge of the bottom plate for the spacer bolts (Item 3B).

5. Fig. 2-16 shows the detail of using three bolts (Item 3B) as spacers for the bottom plate (Item 2B). The length of the bolts should be adjusted to provide a clearance of about 2-in. between the layer of cement in the bottom of the container (Item 1B) and the bottom plate (Item 2B).

6. A rectangular divider plate (Item 4B) should be cut to a width 1/4 in. less than the inside diameter of the filter container (Item 1B) and to a height 2.5 in. less than the inside height of the container. This divider plate should then be welded at a right angle to the centerline of the bottom plate (Item 2B) as shown in Fig. 2-17.

7. Cut a piece of high-temperature hydraulic hose (Item 5B) to a length equal to the circumference of the filter container. It should be slit along its entire length and then placed over the top edge of the filter container (Item 1B) to ensure airtightness.

8. A circular lid (Item 6B) should be cut equal to the outside diameter of the filter container (Item 1B). Three holes should be cut into this lid for the exhaust pipe (Item 29A) from the gasifier unit, the blower (Item 7B), and the filter exhaust pipe (Item 10B) to the engine manifold. Note the arrangement of these holes: the pipe (Item 29A) from the gasifier unit must enter the lid on one side of the divider plate (Item 4B); the blower (Item 7B) and the filter exhaust pipe (Item 10B) to the engine manifold must be located on the other side of the divider plate. This arrangement can be seen in Fig. 2-18.

9. The connecting pipe (Item 29A) between the gasifier unit and the filter unit should be attached to the lid (Item 5B) of the filter container. At least one of the ends of the connecting pipe (Item 29A) must be removable for cleaning and maintenance. On this prototype unit, an airtight electrical conduit connector was used. Many similar plumbing devices are available and can be used if they are suitable for operation at 400° F and above. The pipe can also be welded or brazed directly to the lid.

10. Attach the blower (Item 7B) to the filter container lid (Item 6B). On the prototype gasifier illustrated in this report, a heater blower from a Volkswagen automobile was used. Connections for a vertical extension tube (Item 8B) will have to be fabricated as shown in Fig. 2-19. A closing cap (Item 9B) is required for the blower exhaust tube. A plumbing cap of steel or plastic with a close fit can be used or fabricated to fit. The vertical extension and the closing cap are visible in Fig. 2-1.

11. The gas outlet (Item 10B) to the carbureting unit on the engine should be 1.25 in. minimum diameter. In fabricating this connection, all abrupt bends should be avoided to ensure free flow of gas. Using plumbing elbows is one solution. The gas outlet (Item 10B) can either be welded or brazed to the lid (Item 6B) of the filter container or an airtight, electrical conduit connector can be used.

12. Latching devices (Item 11B) should be welded or brazed to the lid (see Fig. 2-20) and to the sides (see Fig. 2-21) of the filter container. An air-tight connection between the lid and the filter container must be maintained.

13. Cut two lengths of high-temperature hydraulic hose (Item 12B) equal to the height of

the divider plate (Item 4B); cut a third length of hose equal to the width of the divider plate. Slit each hose along its entire length. Place the first two hoses on each side of the divider plate, and place the third hose along the top edge of the divider plate as shown in Fig. 2-17.

14. Insert the divider plate (Item 4B) into the filter container (Item 1B), making sure that the hoses (Item 12B) create an airtight seal along all sides. By changing the length of the spacer bolts (Item 3B), adjust the height of the divider plate so that it is exactly flush with the top of the filter container. Make sure that the lid (Item 5B) will seat flatly and tightly against the top edge of the divider plate.

15. Fill the filter container (Item 1B) on both sides of the divider plate with wood chips, the same kind as would be used for fuel in the gasifier unit. After carefully packing and leveling these wood chips, place the lid (Item 6B) on the filter container, and close the latches tightly.

2.3. BUILDING THE CARBURETING UNIT WITH THE AIR AND THROTTLE CONTROLS

Figures 2-22 and 2-23 show exploded views of the carbureting unit; the list of materials is given in Table 2-4 (all figures and tables mentioned in Sect. 2 are presented at the end of Sect. 2). In the following instructions, all item numbers refer both to Figs. 2-22 and 2-23 and to Table 2-4. The following is a simple and easy way to assemble a carburetor to achieve both air mixture and throttle control. It can be mounted to either updraft or downdraft manifolds by simply turning the unit over. Most of the fabrication procedure below is devoted to the assembly of two butterfly valves: one for the throttle valve and one for the air mixture valve. The remainder of the carburetor unit can be assembled from ordinary, threaded plumbing parts.

The inside diameter of the piping used in the carburetor unit must be related to the size of the engine and should never be smaller than the intake opening on the engine manifold. If in doubt on the inside diameter for the pipe and/or hose sizes, always go with a larger diameter. This will reduce friction losses and will give longer operating hours between cleanings.

When the wood gas leaves the filter unit it should normally be below 180°F. About 2 ft from the filter container, an automotive water hose can be connected to the pipe on the carbureting unit. This rubber hose will keep engine vibration from creating air leaks in the filter unit or in the connecting piping. The hose must be a fairly new item; such hoses have a steel spring inside to keep them from collapsing when negative pressure is applied. The spring will soon rust if it has first been subjected to water and then to the hot wood gas enriched with hydrogen.

The fabrication procedure for the assembly of two butterfly valves follows:

1. The manifold adapter (Item 1C in Fig. 2-22) must be fitted with bolts and/or holes for mounting onto the engine's existing intake manifold. Because gasoline engines are produced with so many different types of intake manifolds, ingenuity and common sense must be used to modify the manifold adapter (Item 1C) for each different engine to be operated on wood gas. A gasket (Item 7C) should be cut to match the shape of the engine intake fitting.

2. The butterfly valve (Item 3C) is shown in Figs. 2-24 and 2-25; two such valves are

required. A 3/8 in. hole should be drilled through the diameter of each valve body (Item 1CC) at the midpoint of its length.

3. The valve plate (Item 2CC) must be oval in shape with the dimensions given in Table 2-4. An oval valve plate must be used so that, in the closed position, the valve will be about 10° off center. This will ensure that the valve will come to a complete stop in the closed position.

4. The edges of the valve plate (Item 2CC), around the longer diameter of the oval, should be beveled to provide a positive, airtight closure. Two evenly spaced, 1/4-in. holes should be drilled along the shorter diameter of the oval plate.

5. The valve support rod (Item 3CC) should be filed or ground flat on one side as shown in Fig. 2-24; the flat area must begin 1/4 in. from one end and must continue for a distance equal to the inside diameter of the valve body (Item 1CC).

6. Two 3/16 in. holes should be drilled into the flat area of the valve support rod (Item 3CC); these holes must align with the holes in the valve plate (Item 2CC). They must also be tapped (with threads) to accept the valve plate screws (Item 4CC).

7. The butterfly valve (Item 3C) should be assembled by first placing the valve support rod (Item 3CC) through the hole in the valve body (Item 1CC). The valve plate (Item 2CC) should be dropped into one end of the valve body and then inserted into the flat area of the valve support rod. The two screws (Item 4CC) should be used to attach the valve plate to the support rod. Check to see that the assembled valve plate rotates freely and seats completely in the closed position.

8. A nut (Item 6CC) should be welded flat against one side of the throttle arm (Item 5CC) near its end. A 1/8-in. hole should be drilled into the side of the nut and must be threaded to accept the set screw (Item 7CC). At least one hole should be drilled into the throttle arm for attachment of the engine throttle control or air control linkages.

9. Place the nut (Item 6CC) on the throttle arm over the end of the valve support rod (Item 3CC) and use the set screw (Item 7CC) to secure the assembly. The throttle arm can be placed in any convenient orientation. Assembled butterfly valves are shown in Fig. 2-26.

10. The remaining parts of the carburetor assembly should be screwed together as shown in Fig. 2-27. Pipe thread compound should be used to make airtight connections. The assembled carburetor unit should be attached to the engine's intake manifold as shown in Fig. 2-28

11. This prototype gasifier was designed to operate if gasoline were unavailable; but, if dual operation on wood and gasoline is desired, the elbow (Item 2C) could be replaced with a tee, allowing a gasoline carburetor to also be mounted.

12. The arm on the butterfly valve (Item 3C) which is closest to the elbow (Item 2C) is to be connected to the foot- (or, on tractors, hand-) operated accelerator. The other butterfly valve is to be used as the air mixture control valve and can be operated with a manual choke cable. If the engine has an automatic choking device, then a hand-

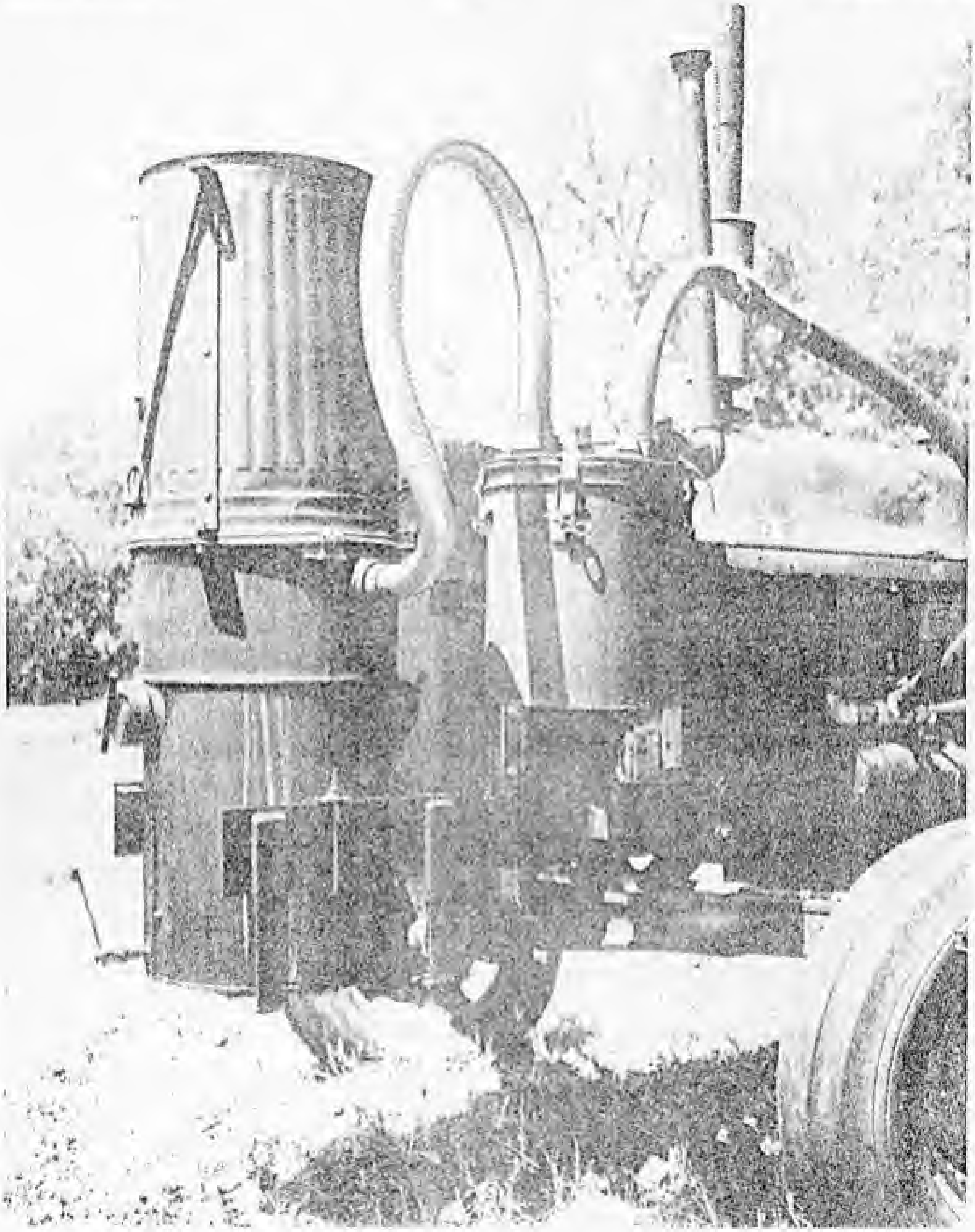


Fig. 2-1. The prototype wood gas generator unit mounted onto a tractor.

operated choke cable should be installed. Both butterfly valves and their connecting control linkages must operate smoothly with the ability to adjust the valve yet keep it stationary in the selected position during operation. The linkages must close the valves airtight when the engine is off.

13. The air inlet (Item 6C) should be connected by an extension hose or pipe, either iron

or plastic, to the existing engine's air filter in order to prevent road dust or agricultural residue from entering the engine.

14. The wood gas inlet (Item 5C) is to be connected to the outlet piping (Item 10B as shown in Fig. 2-15) from the wood gas filter unit. Part of this connection should be a high-temperature rubber or neoprene hose to absorb engine vibration.

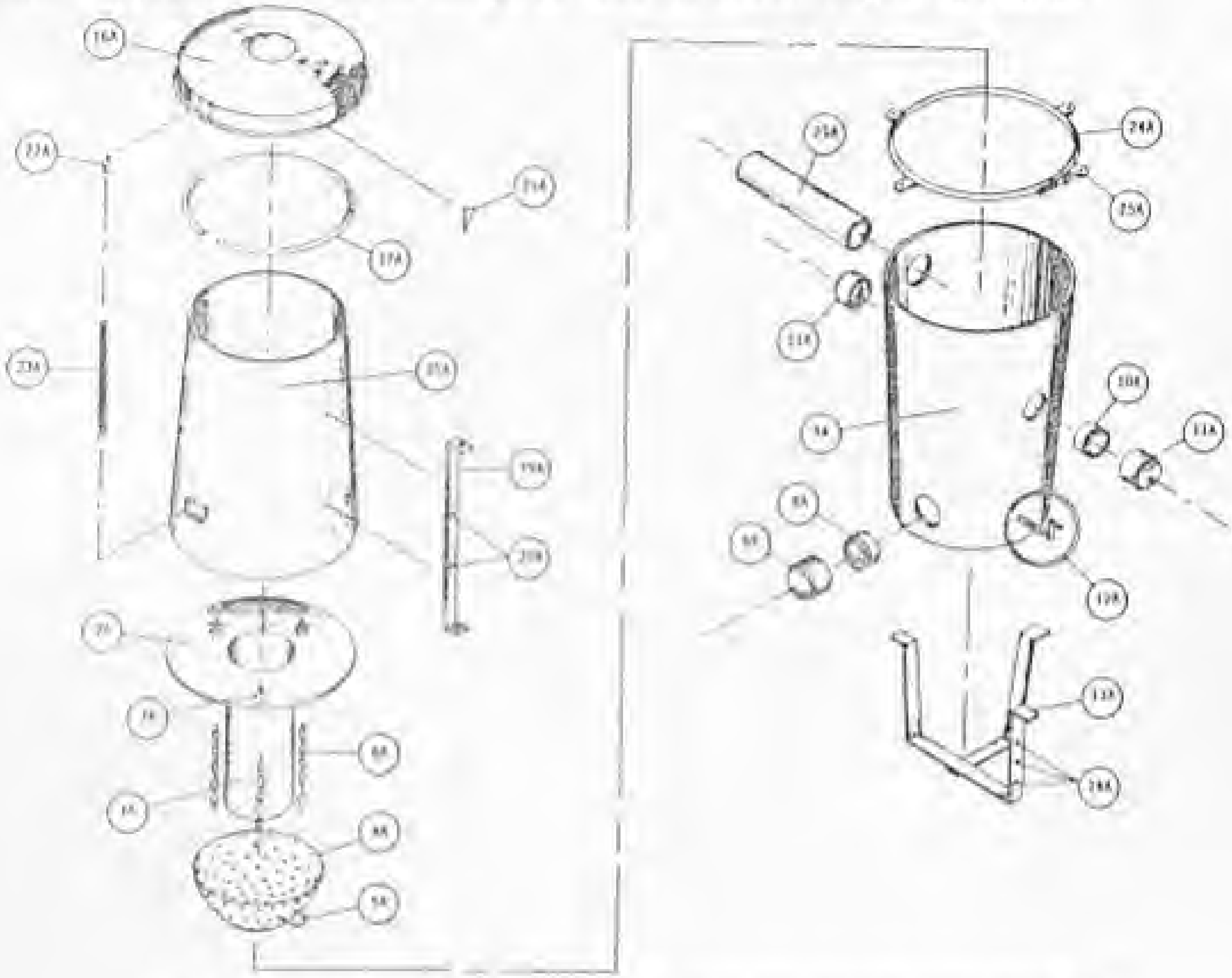


Fig. 2-2. Exploded, schematic diagram of the wood gas generator unit and the fuel hopper.

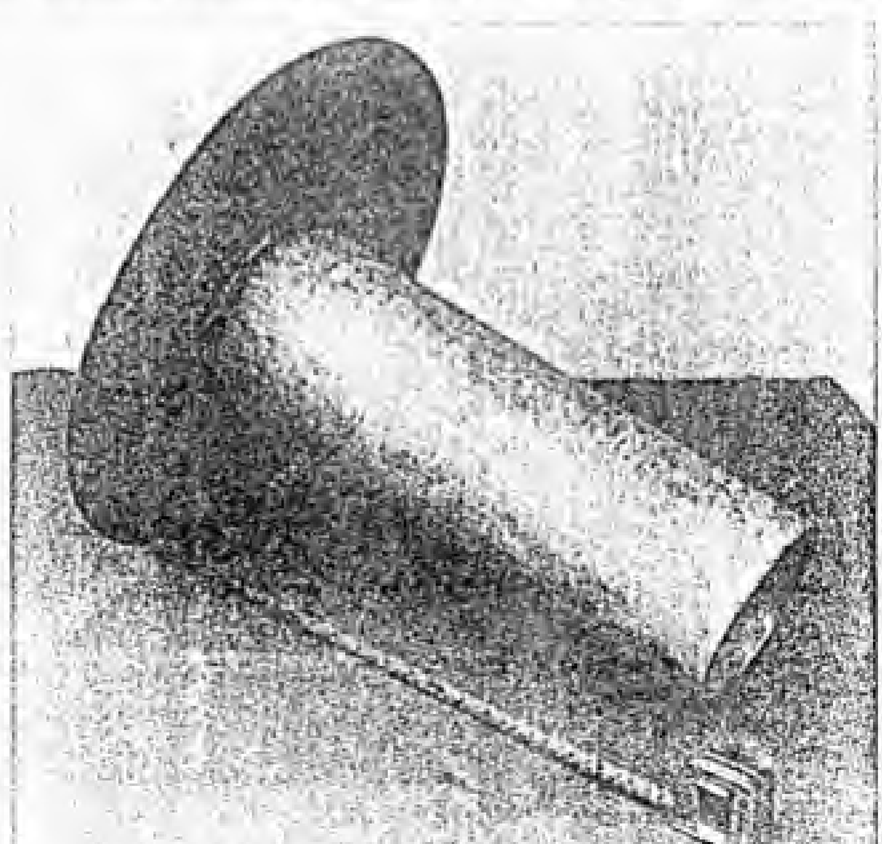


Fig. 2-3. The fire tube and circular top plate of the gasifier unit.

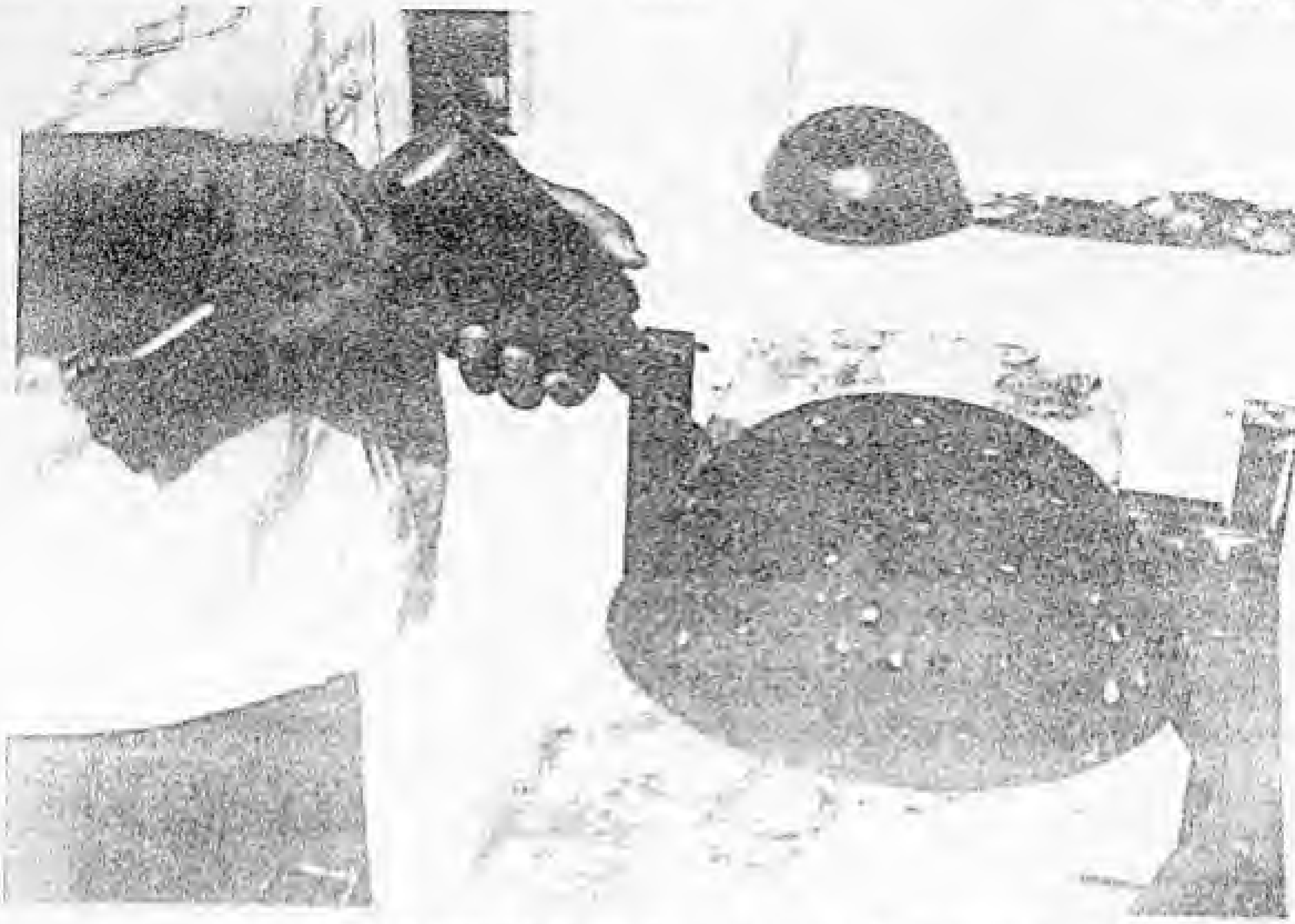


Fig. 2-4. Drilling holes into the stainless steel mixing bowl to be used for the grate. Note the U-bolt in the foreground.

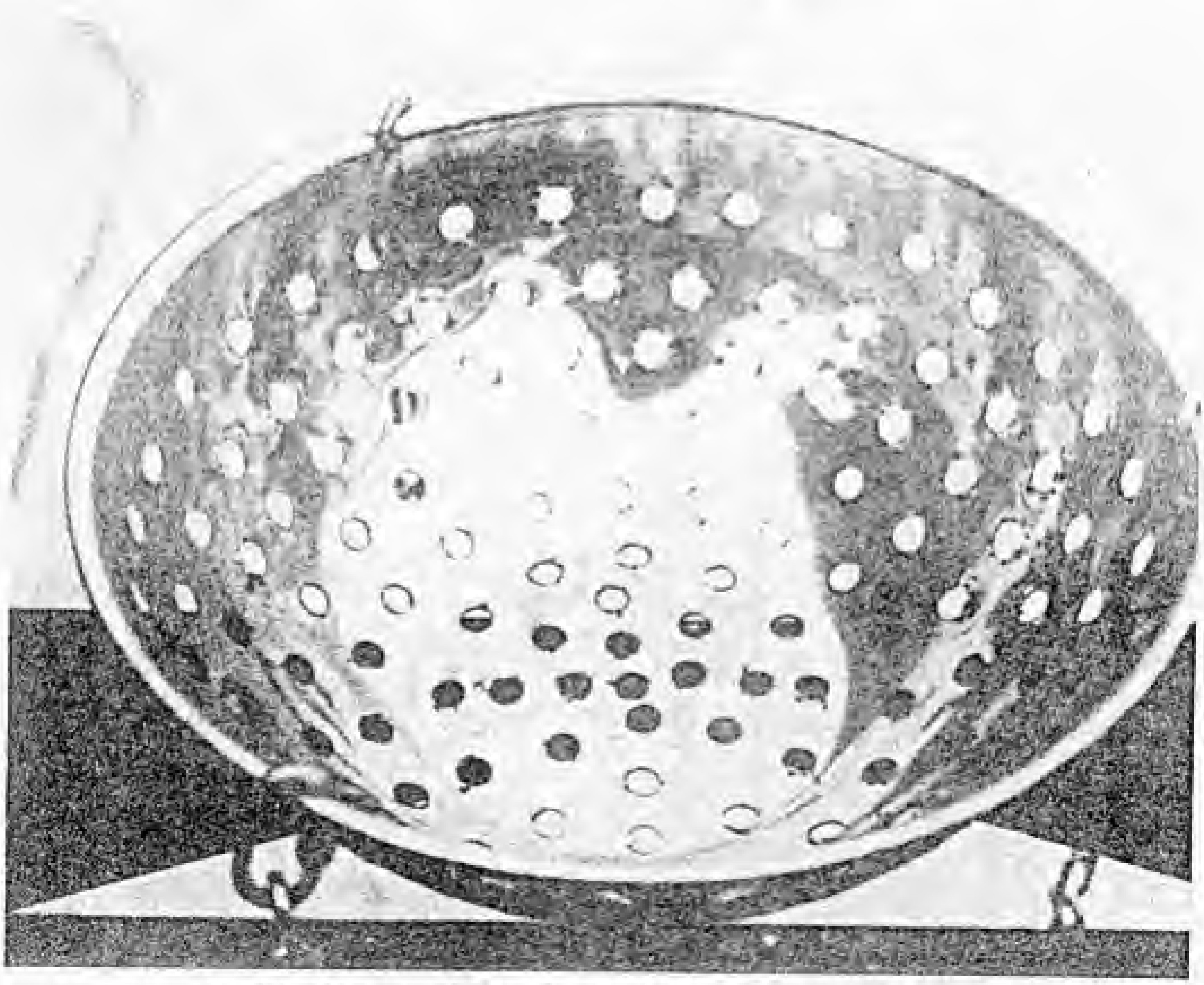


Fig. 2-5. Chains attached to the lip of the stainless steel mixing bowl.

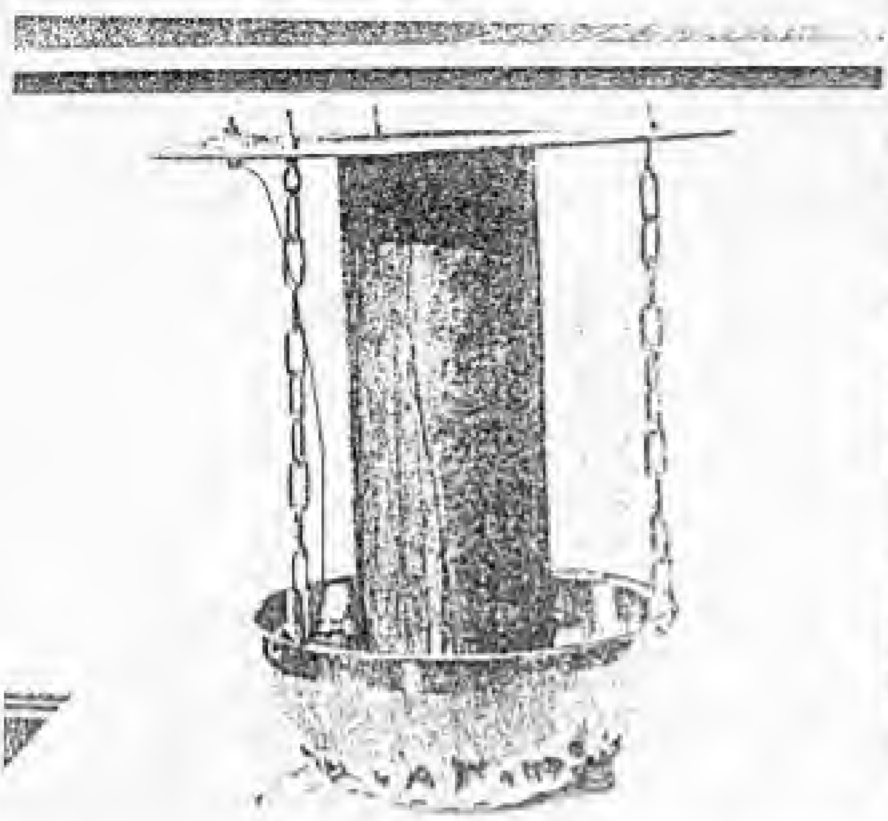


Fig. 2.6. Connect the mixing bowl to the top plate with chains. Note that the diesel ignitor 'glow plugs' shown in this photograph were included for experimentation only; they were abandoned in the final prototype design.

Fig. 2.7. Braze, do not weld, the plumbing fittings to the thin walled drum.

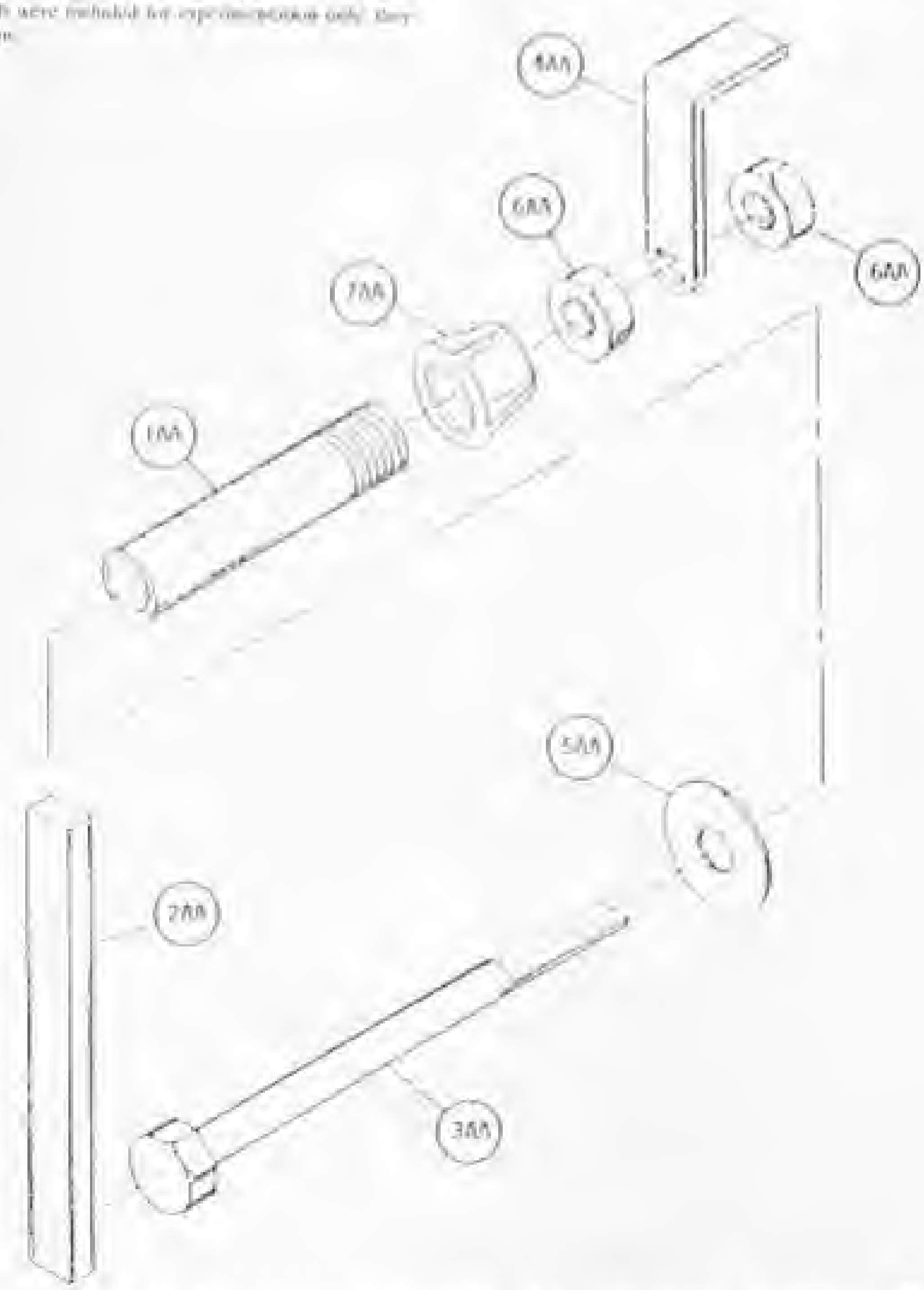


Fig. 2.8. Exploded, schematic diagram of the grate shaking mechanism.

Fig. 2-9. Parts for the shaker assembly. Note the flattened portion of the bolt (at extreme left) which positively locks into the handle (third from right). At the extreme right is a "poker bar" which engages into the hole in the top of the handle to operate the shaker mechanism; the shaker handle will get very hot during normal gasifier operation.

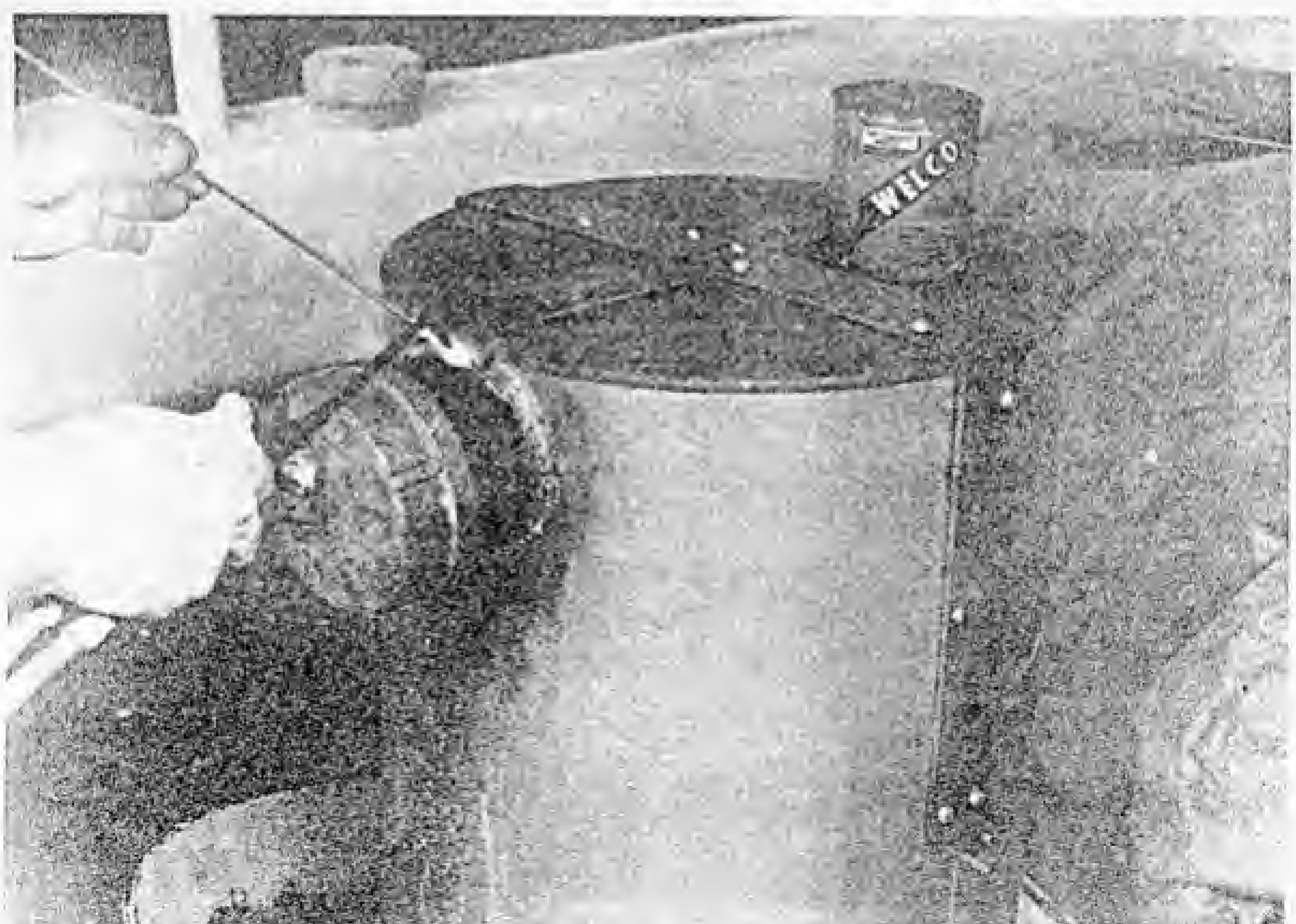


Fig. 2-10. The support frame can be brazed or bolted to the side of the gasifier unit. All bolts should be sealed air tight.

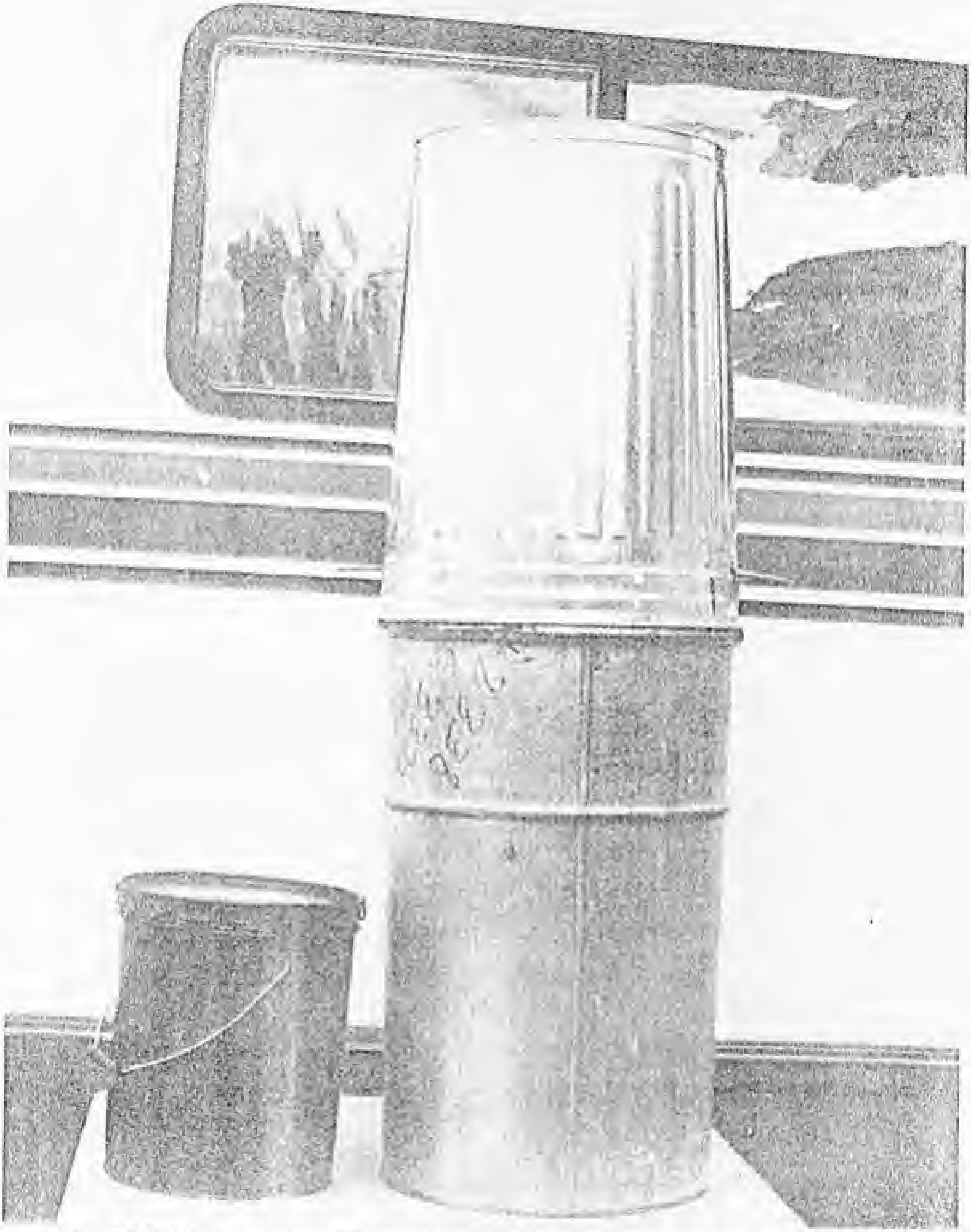


Fig. 2-11. Containers used in constructing the prototype gasifier unit. At right, a 20-gal garbage can (the fuel hopper) is shown on top of a 30-gal metal drum (the gasifier unit housing). The 5-gal paint can, at left, is used as the filter container.

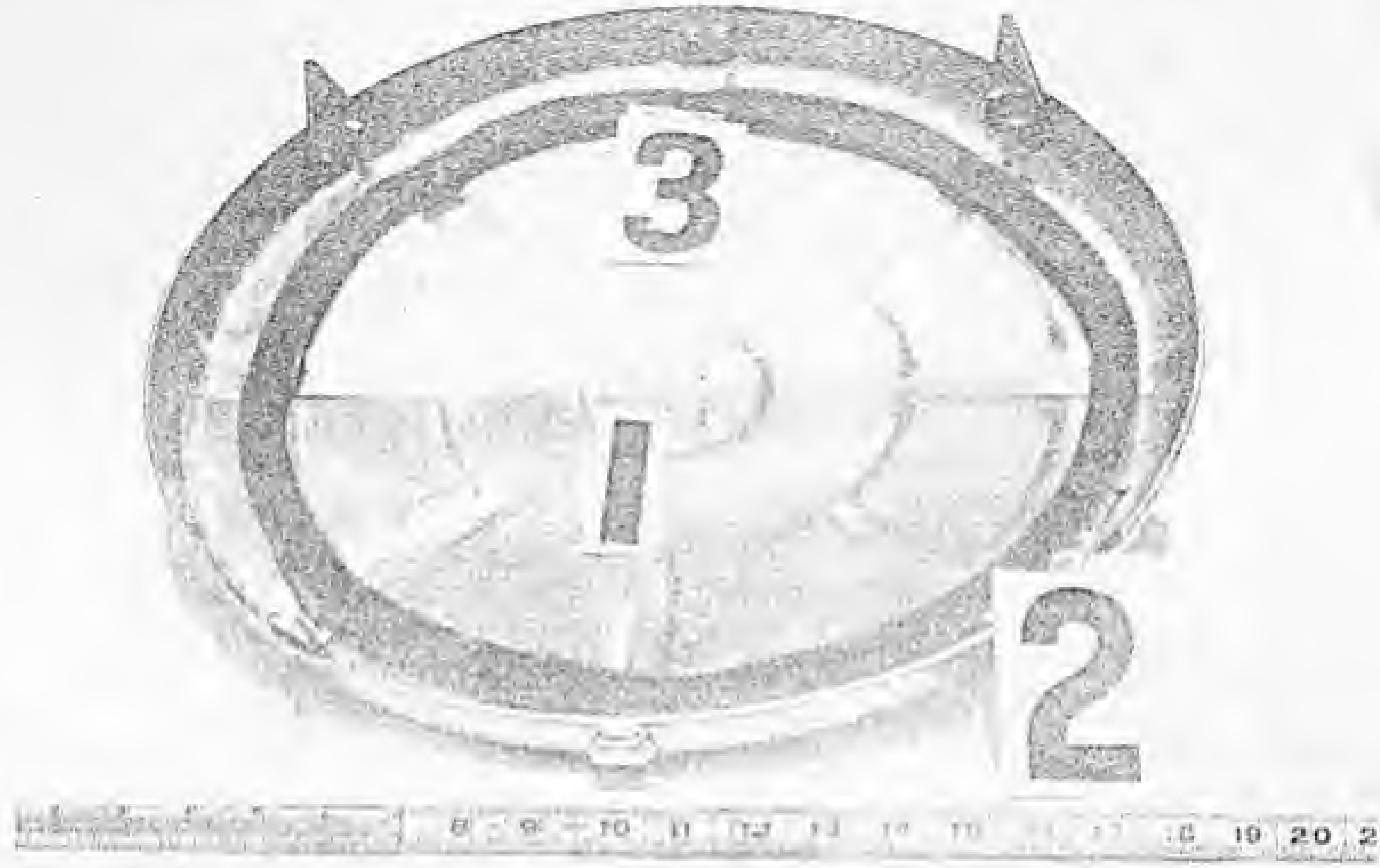


Fig. 2-12. Cover for the fuel hopper. Note the foam weatherstripping (#3) attached to the underside of the lid where it contacts the fuel hopper. Attach four standoffs (#2) to the lid (#1) as shown.

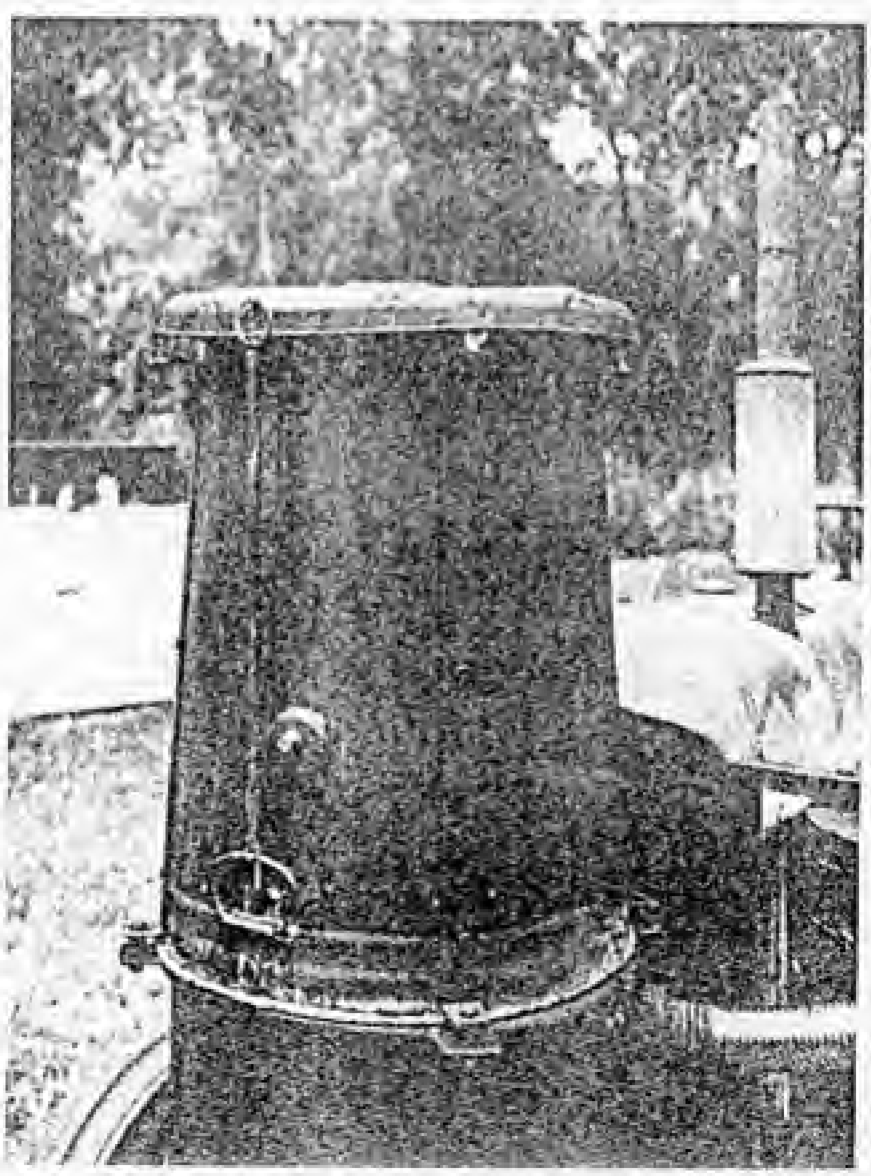


Fig. 2-13. Operating configuration of the fuel hopper and its cover.

Fig. 2-14. Lock ring and welded tabs. Also pictured inside the lock ring (#1): the ash element cover cap (#2), and the ignition cover cap (#3).

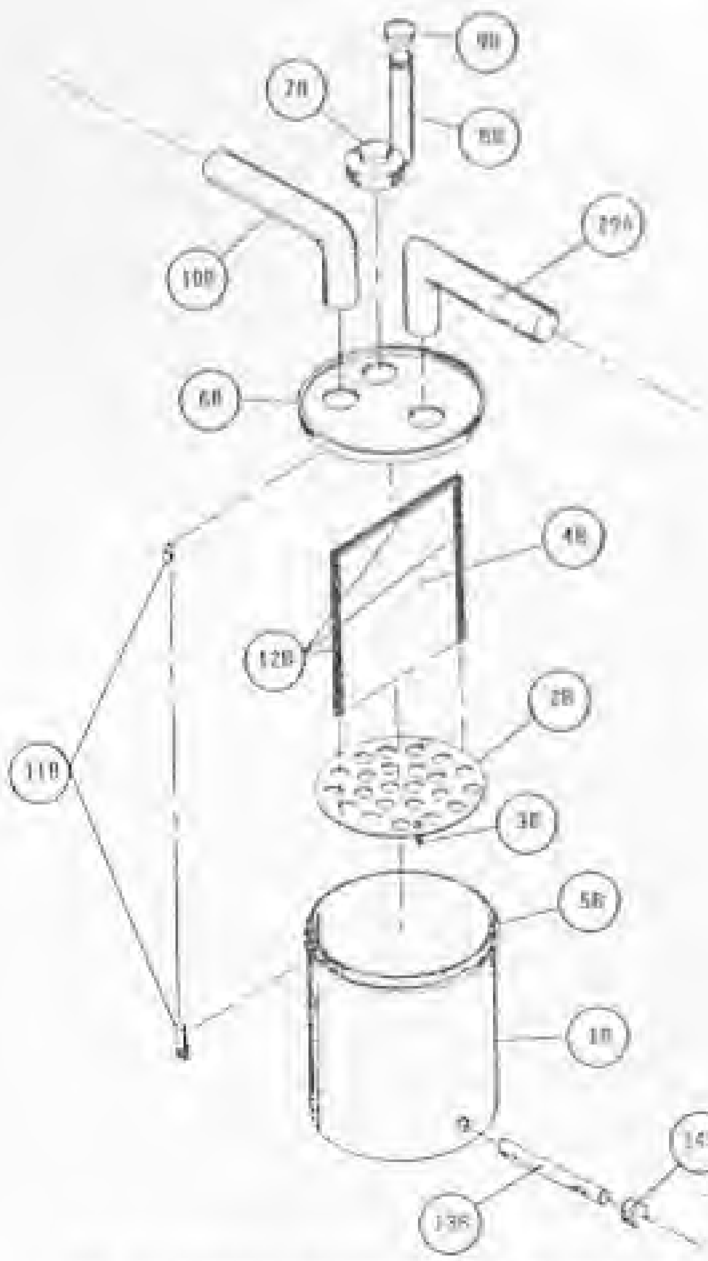


Fig. 2-15. Exploded, schematic diagram of the filter unit.

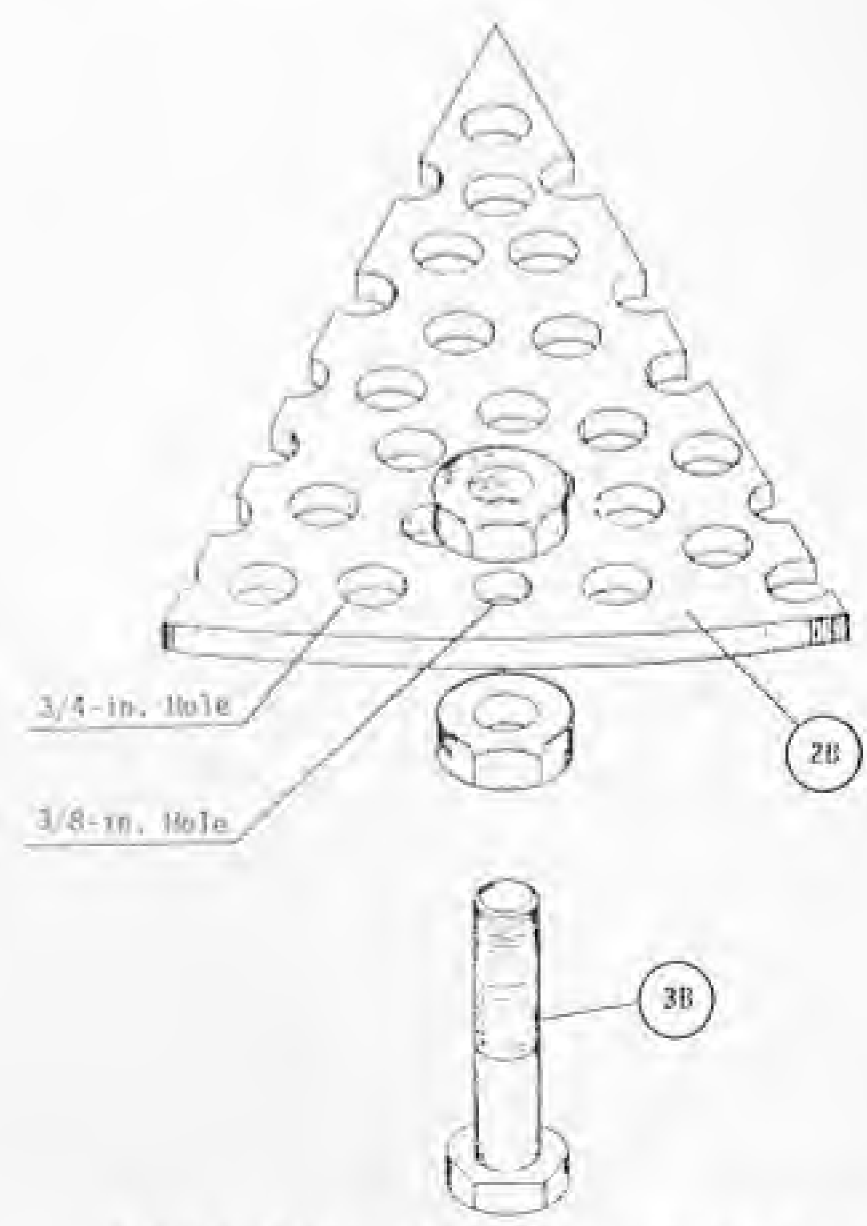


Fig. 2-16. Detail of the standoffs for the bottom plate of the filter unit.

Fig. 2-17. Divider plate (#1) and bottom plate (#3), **with standoffs (#4), for the filter** unit. Note the high temperature hose lining the sides of the divider plate.

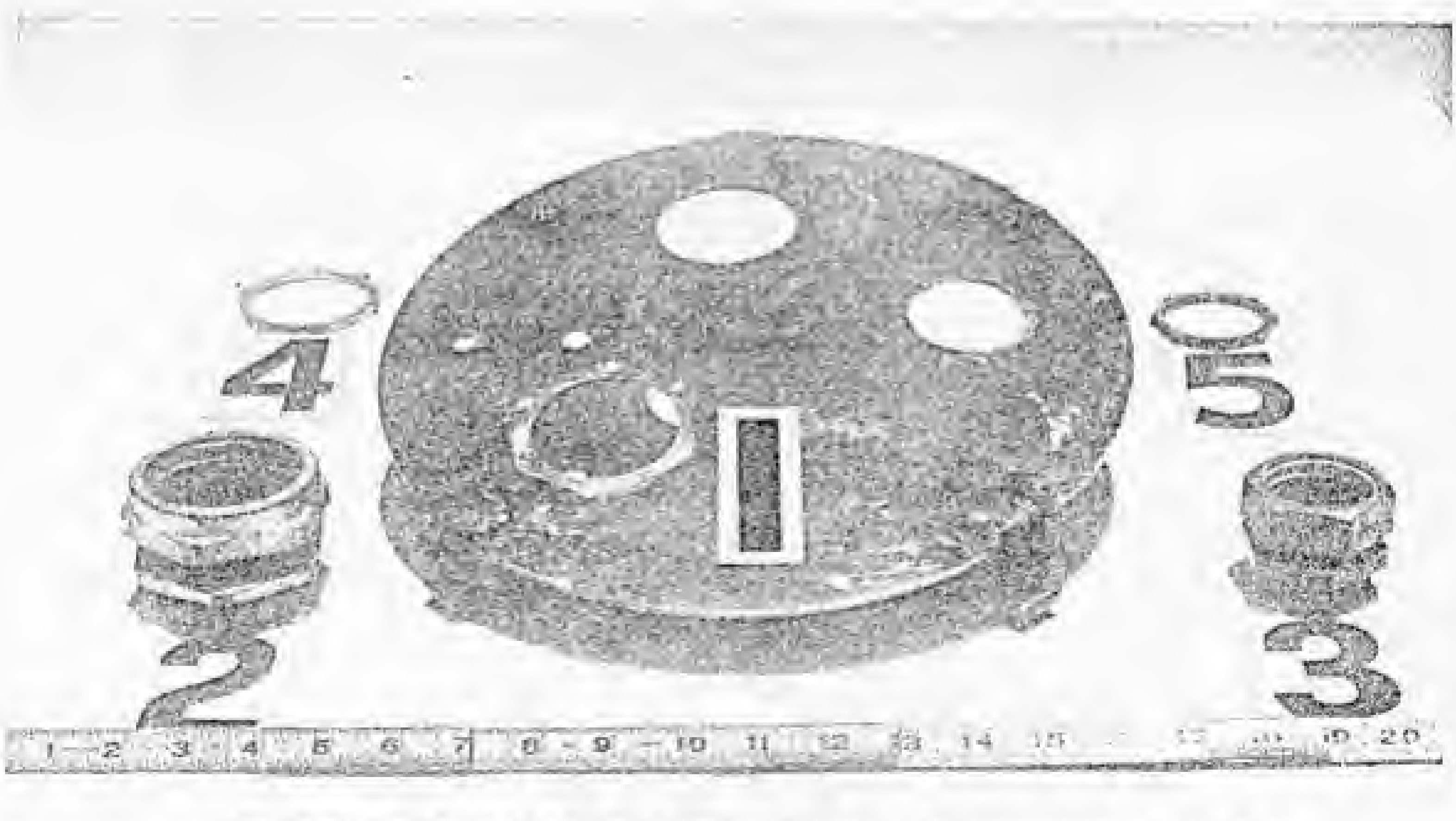


Fig. 2-18. **Circular lid (#1) for the filter unit.** Note the arrangement of the holes; divider plate would roughly run from 10 o'clock position to 4 o'clock position (assuming 12 o'clock is taken to be at the rear of the photograph). Also shown are the conduit connectors (#2 and #3) and accompanying nuts (#4 and #5) for inside the lid.

Fig. 2-20. Assembled and installed blower (#1), extension assembly (#4), and conduit connectors for gas inlet (#2) and outlet (#3) on lid of filter unit. Note hook attachments at edge of lid for latches.

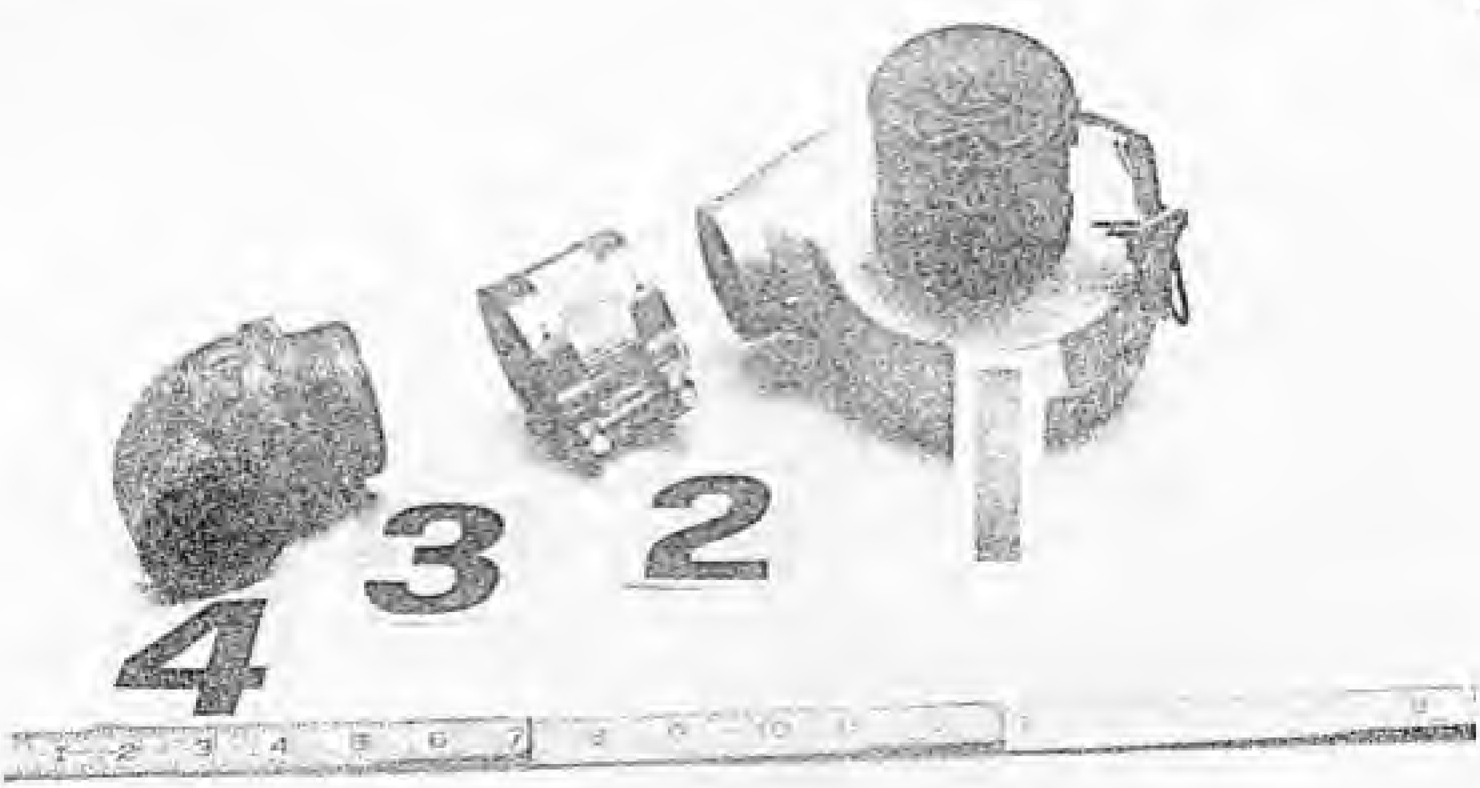


Fig. 2-19. Blower (#1) with exhaust extension assembly. Note adapter coupling (#2), pipe nipple (#3), and elbow (#4) for vertical exhaust pipe.

Fig. 2-21. Filter container (#1) showing latches (#2) for lid and hose (#3) around top.

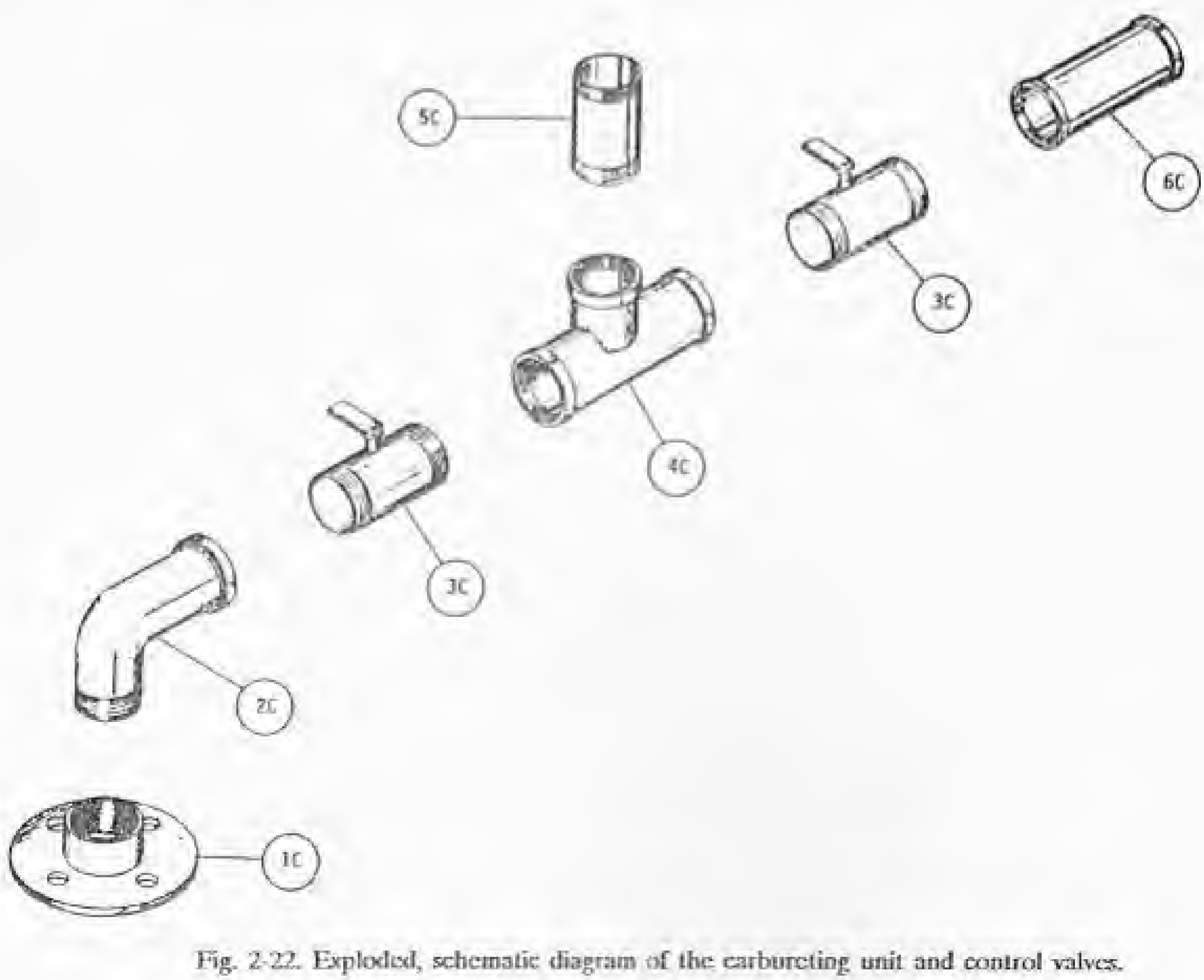


Fig. 2-22. Exploded, schematic diagram of the carburcting unit and control valves.

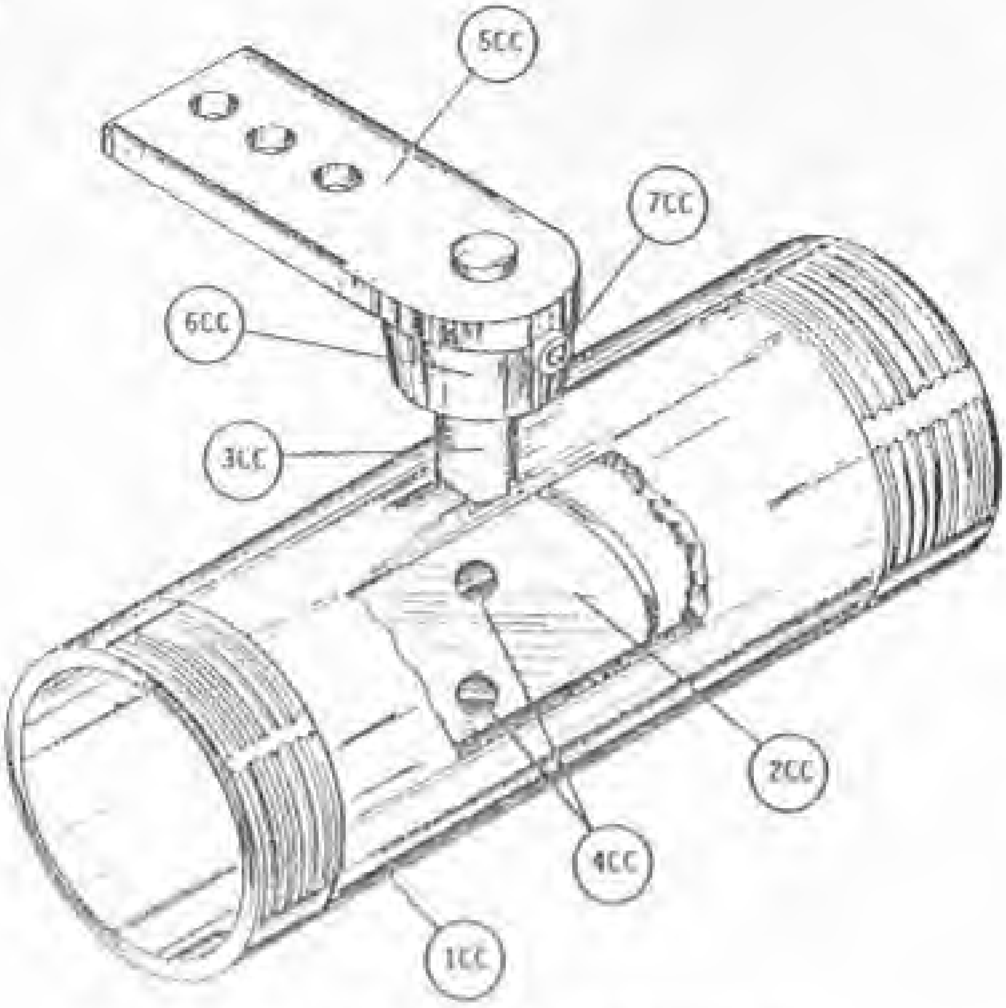


Fig. 2-23. Schematic diagram of a butterfly control valve.

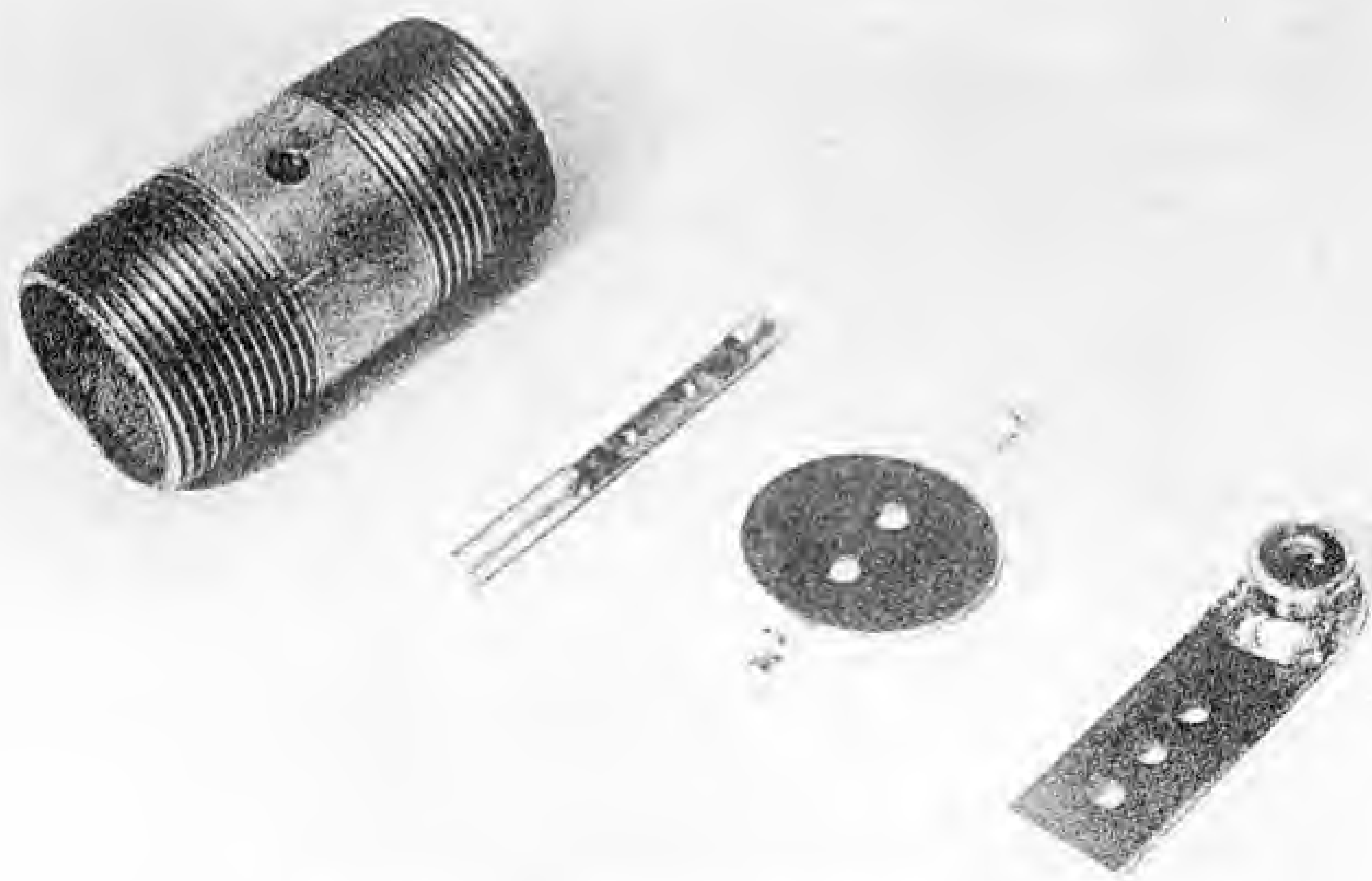


Fig. 2-24. Parts required for the butterfly valve.

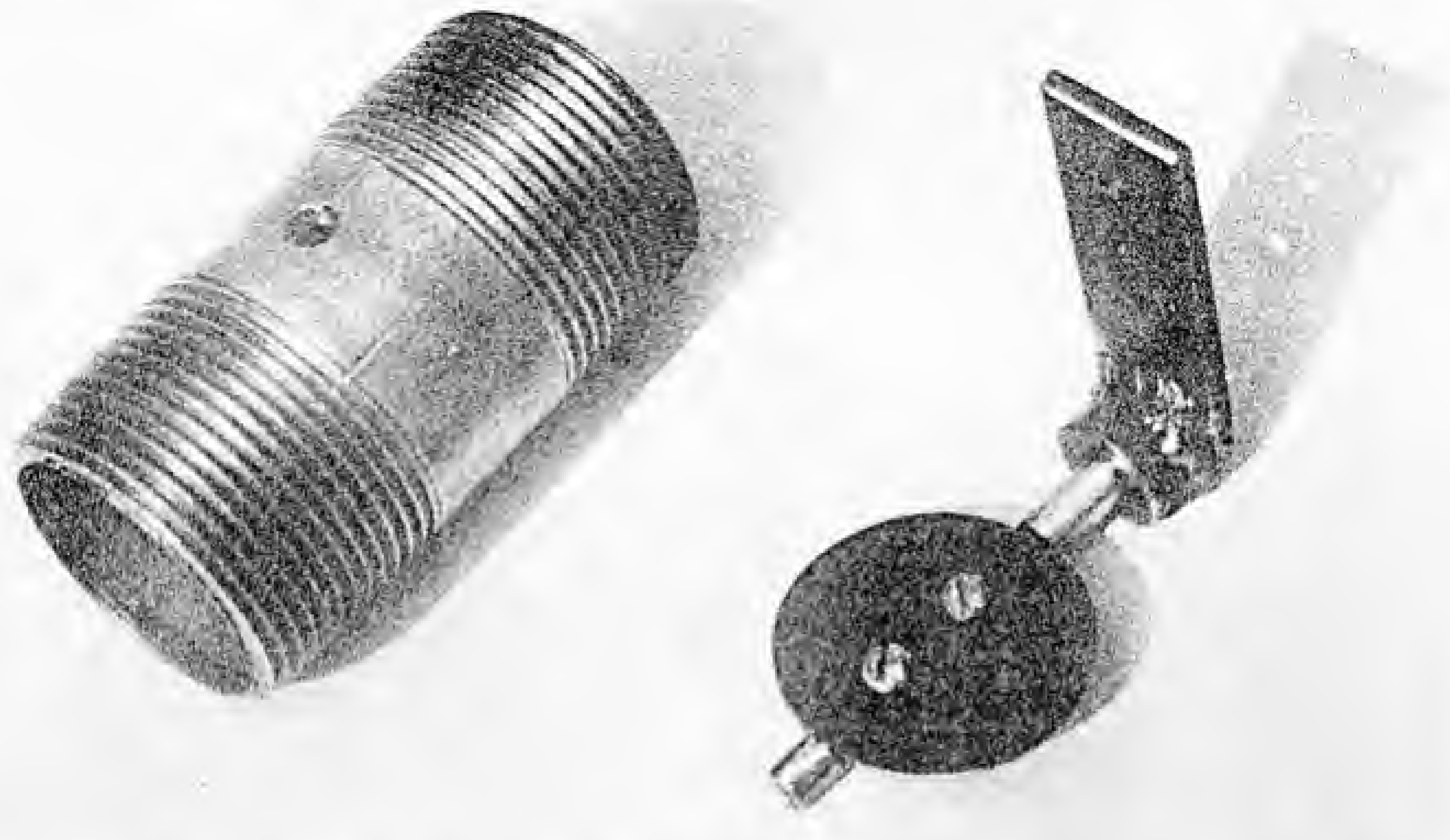


Fig. 2-25. Butterfly valve assembly. Note that the valve has been assembled outside of the valve body for clarity.

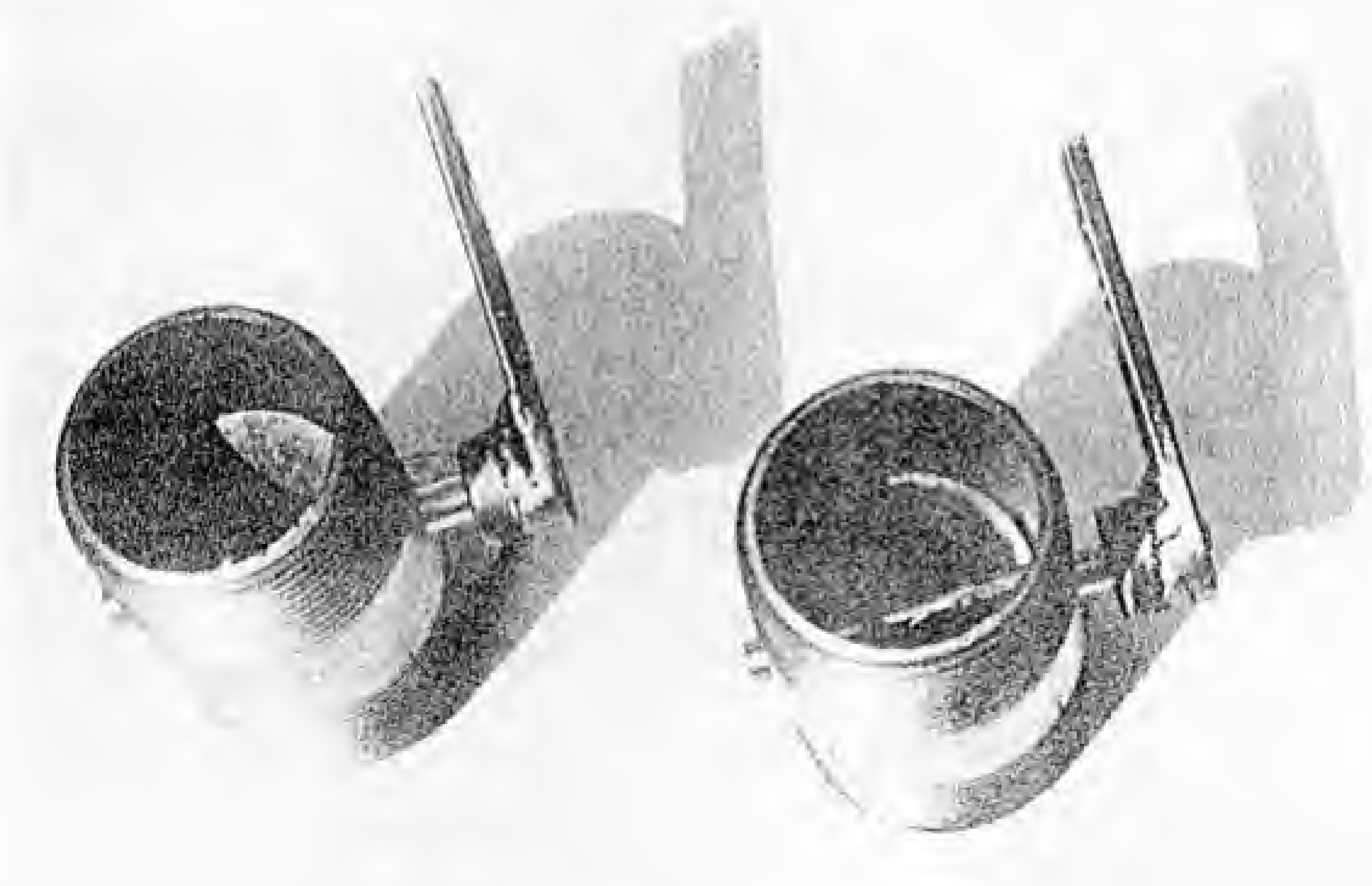


Fig. 2-26. Assembled butterfly valves.

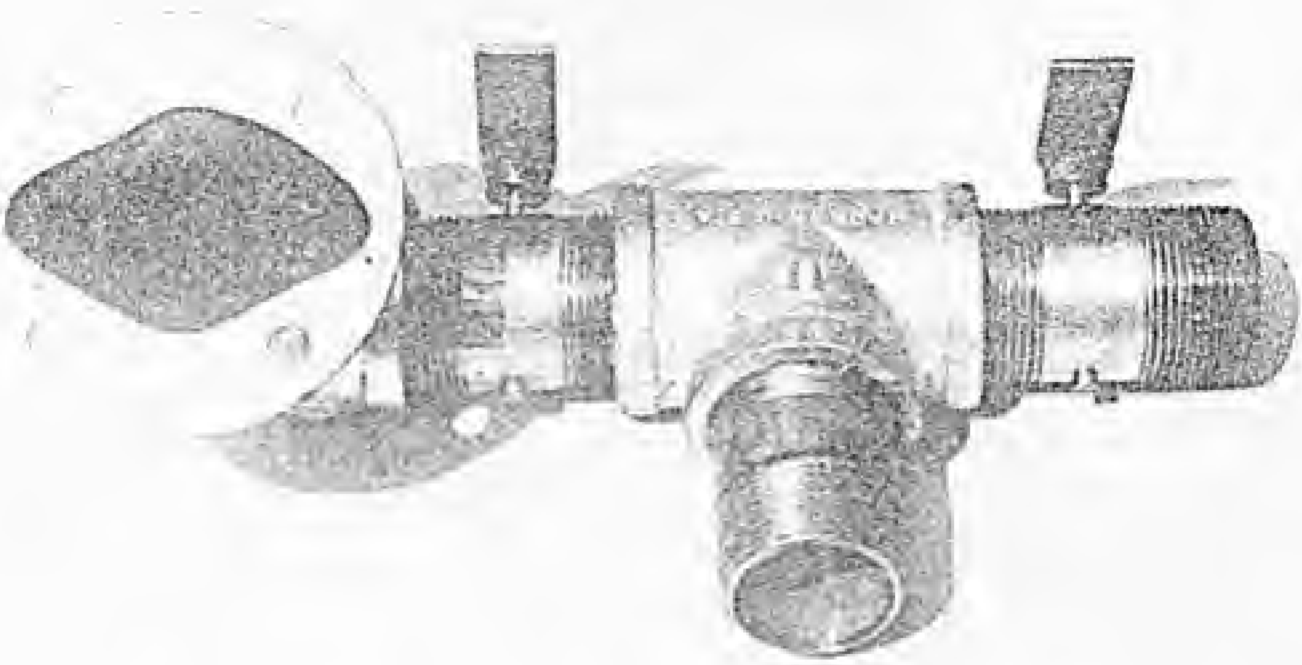


Fig. 2-27. Assembled carburetion unit. Note the gasket on the closet flange.

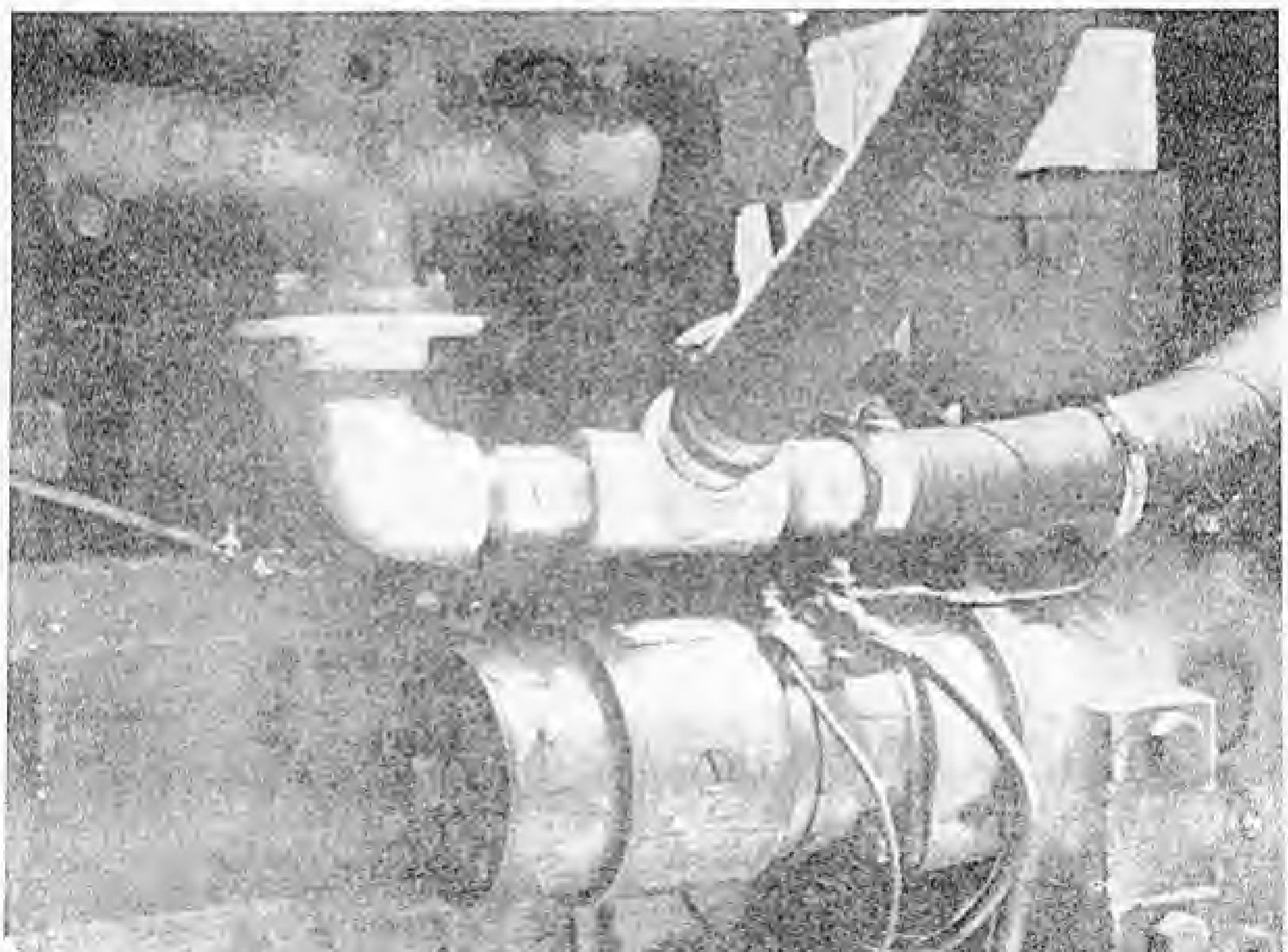


Fig. 2-28. Carburetion unit attached to engine's existing intake manifold. Wood gas enters from the side of the tee; air enters from the right-hand end. The butterfly valve at the right (partially obscured) is connected to the air control (choke) cable; the left valve is connected to the throttle linkage.

Table 2-1. List of materials for the gasifier unit and the wood fuel hopper

Item	Quantity	Description
1A	1	Metal pipe, tube, or other, open-ended metal cylinder; diameter and length from Table 2-2; minimum wall thickness of 1/4 in.
2A	1	Circular metal plate with thickness of 1/8 in.; diameter equal to outside diameter of Item 1A.
3A	1	30-gal metal oil drum or metal container with approximate dimensions of 18 in. (diameter) by 29 in. (height); container must have a bottom.
4A	1	10-quart stainless steel mixing bowl, colander, or other stainless steel bowl with approximately 14-in. diameter and 6-in. depth.
5A	1	2-in. metal U-bolt.
6A	1	3/16-in. metal chain with 1-in. links; 7 ft total length.
7A	3	1/4 in. eyebolts, 3 in. length with two nuts for each eyebolt.
8A	1	4-in. metal pipe nipple.
9A	1	Metal pipe cap for Item 8A.
10A	2	3-in. metal pipe nipple.
11A	2	Metal pipe cap for Item 10A.
12A		Shaker assembly; see Fig. 2-8.
1AA	1	Metal 1/2-in. pipe; 6 in. length.
2AA	1	Iron bar stock; square or round, 1/2 in.; 6 in. length.
3AA	1	1/2-in. bolt; 8 in. long.
4AA	1	Iron bar stock; rectangular, 1/4 by 1 in.; 10 in. length.
5AA	1	1/2 in. flat washer.
6AA	2	1/2-in. nuts.
7AA	1	Metal pipe cap or bushing for Item 1AA.
13A	1	Iron bar stock; rectangular, 1/4 by 2 in.; 10 ft length.
14A	25	1/4-in. bolts; 3/4 in. length, with nuts.
15A	1	20-gal metal garbage can or metal container with approximate

		dimensions of 18 in. (top diameter) by 24 in. (height); bottom is not required.
16A	1	Lid for 20-gal garbage can.
17A	1	Garden hose; 1/2 to 5/8 in. diameter; length equal to circumference of Item 15A.
18A	1	Foam weather stripping with adhesive backing; 1/4 by 1 in.; length equal to circumference of Item 15A.
19A	1	Iron bar stock; rectangular, 1/4 by 2 in.; 10 ft length.
20A	12	1/4-in. bolts; 3/4 in. length; with nuts.
21A	4	Metal triangles; 2 by 2.5 in., 1/8 to 1/4 in. thick.
22A	2	Metal eye hook.
23A	2	Screen door spring, 14 in. length.
24A	1	Lock ring for 30 gal (or larger) oil drum.
25A	4	Metal squares; 2 by 2 in., 1/4 in. thick.
26A	4	3/8-in. bolts; 3 in. length.
27A	1	Tube of high temperature silicone or liquid high temperature gasket material.
28A	1	60-lb. sack of hydraulic or other waterproof cement [such as SEC-PLUG (tm), which is manufactured by the Atlas Chemical Company, Miami, FL].
29A	1	2-in. pipe, electrical conduit, flexible automobile exhaust pipe, or other metal tubing; 6-ft minimum length. Pipe must be able to withstand temperatures of 400°F.

Table 2-2. Fire tube dimensions

Inside diameter (inches)	Minimum length (inches)	Engine power (horsepower)	Typical engine displacement (cubic inches)
2[a]	16	5	10
4[a]	16	15	30
6	16	30	60
7	18	40	80

8	20	50	100
9	22	65	130
10	24	80	160
11	26	100	200
12	28	120	240
13	30	140	280
14	32	160	320

*A fire tube with an inside diameter of less than 6 in. would create bridging problems with wood chips and blocks. If the engine is rated at or below 15 horsepower, use a 6-in. minimum fire tube diameter and create a throat restriction in the bottom of the tube corresponding to the diameter entered in the above table.

NOTES:

For engines with displacement rated in liters, the conversion factor is 1 liter = 61.02 cubic inches.

The horsepower listed above is the SAE net brake horsepower as measured at the rear of the transmission with standard accessories operating. Since the figures vary when a given engine is installed and used for different purposes, such figures are representative rather than exact. The above horsepower ratings are given at the engine's highest operating speed.

Table 2-3. List of materials for the primary filter unit

Item	Quantity	Description
1B	1	5-gal metal can or other metal container with minimum dimensions of 11.5-in. diameter and 13 in. tall.
2B	1	Circular metal plate; diameter equal to 1/2 in. smaller than inside diameter of Item 1B; thickness of 1/8 in.
3B	3	3/8-in. bolts; 3 in. length with two nuts for each bolt.
4B	1	Rectangular metal plate; width equal to 1/4 in. smaller than inside diameter of Item 1B; height equal to 2.5 in. smaller than internal height of Item 1B; 1/8 in. thick.
5B	1	High-temperature hose, 3/8 to 5/8 in. diameter; length equal to circumference of Item 1B.
6B	1	Circular metal plate; diameter equal to outside diameter of Item 1B; thickness of 1/8 in.

7B	1	12-volt blower (automotive heater type); case and fan must be all metal.
8B	1	Metal extension pipe for blower outlet, including elbows and connections for vertical orientation; 1 ft. minimum length.
9B	1	Cap for Item 8B; plastic is acceptable.
10B	1	1.25-in. metal pipe, electrical conduit, automotive exhaust pipe, or other metal tubing; 2 ft minimum length.
11B	3	Metal latch for securely connecting Items 1B and 6B together. Such devices as suitcase or luggage catches, bail-type latches, window sash catches (with strike), or wing-nut latches are acceptable.
12B	1	High-temperature hose, 3/8 to 5/8 in. diameter; length equal to three times the height of Item 4B.
13B	1	Metal 1/2-in. pipe, threaded on one end; 8 in. length.
14B	1	Metal pipe cap for Item 13B.

Table 2-4. List of materials for the carbureting unit

Item	Quantity	Description
1C	1	1.25-in. closet flange.
2C	1	1.25-in. male-to-female 45° pipe elbow.
3C		Butterfly valve; see Fig. 2-23.
1CC	2	1.25-in. pipe nipple or threaded length of pipe, 3-in. length.
2CC	2	Oval metal plate; 1/16 in. thick; short dimension equal to inside diameter of Item 1CC; long dimension equal to 1.02 times the short dimension.
3CC	2	3/8-in. diameter rod; 2.5 in. length.
4CC	4	3/16-in. screws; 3/16 in. length.
5CC	2	Flat bar stock; rectangular, 1/2 by 3 in.; 1/8 in. thick.
6CC	1	7/16-in. nut.
7CC	1	1/8-in. set screw.
4C	1	1.25-in. tee with all female threads.

5C	1	1.25-in. pipe nipple or threaded length of pipe, 3 in. length.
6C	1	1.25-in. pipe or hose.
7C	1	Gasket material; sized to cover Item 1C.
8C	1	Tube of pipe compound or Teflon tape for sealing threaded assemblies.

3. OPERATING AND MAINTAINING YOUR WOOD GAS GENERATOR

3.1 USING WOOD AS A FUEL

Because wood was used extensively as generator fuel during World War II, and since it is plentiful in most parts of the populated United States, it merits particular attention for use as an emergency source of energy. When used in gas generators, about 20 lb of wood have the energy equivalence of one gallon of gasoline.

Wood consists of carbon, oxygen, hydrogen, and a small amount of nitrogen. As a gas generator fuel, wood has several advantages. The ash content is quite low, only 0.5 to 2% (by weight), depending on the species and upon the presence of bark. Wood is free of sulphur, a contaminant that easily forms sulfuric acid which can cause corrosion damage to both the engine and the gas generator. Wood is easily ignited–a definite virtue for the operation of any gas generator unit.

The main disadvantages for wood as a fuel are its bulkiness and its moisture content. As it is a relatively light material, one cubic yard of wood produces only 500 to 600 lb of gas generator fuel. Moisture content is notoriously high in wood fuels, and it must be brought below 20% (by weight) before it can be used in a gas generator unit. By weight, the moisture in green wood runs from 25 to 60%, in air-dried wood from 12 to 15%, and in kiln-dried wood about 8%. Moisture content can be measured quite easily by carefully weighing a specimen of the wood, placing it in an oven at 220°F for thirty minutes, reweighing the specimen, and reheating it until its weight decreases to a constant value. The original moisture content is equivalent to the weight lost.

The prototype unit in this manual (with an 6-in.-diam firetube) operated well on both wood chips (minimum size: 3/4 by 3/4 by 1/4 in.) and blocks (up to 2-in. cubes); see Fig. 3-1 (all figures and tables mentioned in Sect. 3 are presented at the end of Sect. 3). Larger sizes could be used, if the firetube diameter is increased to prevent bridging of the individual pieces of wood; of course, a throat restriction would then have to be added to the bottom of the firetube so as to satisfy the dimensions in Table 2-2 in Sect. 2.

3.2 SPECIAL CONSIDERATIONS AND ENGINE MODIFICATIONS

To start the fire in the gasifier, the blower must be used to create a suction airflow through the wood in the hopper and downward in the firetube. If an especially high horsepower engine is to be fueled by the gasifier unit, then it might be necessary to install two such blowers and run them simultaneously during start-up.

When the wood gas leaves the gasifier unit, all the oxygen pulled down with the air through the firetube has been chemically converted and is contained in carbon monoxide (CO) and water (H_2O). The wood gas is unable to burn without being mixed with the proper amount of additional oxygen. If an air leak develops below the grate area, the hot gas will burn while consuming the available oxygen and will create heat; this will almost certainly destroy the gasifier unit if it is not detected soon. If an air leak develops in the filter unit or in the connecting piping, the gas will become saturated with improper amounts of oxygen

and will become too dilute to power the engine. Therefore, airtightness from the gasifier unit to the engine is absolutely essential.

Ideally, as the wood gas enters the engine manifold it should be mixed with air in a ratio of 1:1 or 1.1:1 (air to gas) by volume. The carburetion system described in this report will provide this mixture with a minimum of friction losses in the piping. The throttle control valve and the air control valve must be operable from the driver's seat of the vehicle.

The engine's spark plug gaps should be adjusted to between 0.012 and 0.015 in.; the ignition timing should be adjusted to "early."

3.3 INITIAL START-UP PROCEDURE

Initially, you will need to add charcoal to the grate below the firetube. Subsequent operation will already have the grate full of charcoal which has been left over from the previous operating period.

Fill the firetube with charcoal* to a level 4 in. above the grate. Fill the hopper with air-dried wood; then, proceed with the routine start-up directions below.

*Charcoal produced for outdoor barbecue grills is not well suited for gas generator use. To produce a better grade of charcoal, place a rag soaked in alcohol on the grate, or place 3 to 5 pages of newspaper on the grate, then fill the fire tube to a height of 10 to 12 in. with well-dried wood. Have all the valves closed and let the fire tube act as a chimney until the wood is converted to charcoal.

3.4 ROUTINE START-UP PROCEDURE

1. Agitate the grate shaker handle for at least twenty seconds to shake down the charcoal from the previous operating period.

2. Open the ash cleanout port and remove the ashes from the generator housing drum. Lubricate the threads of the cleanout port with high-temperature silicone, and close the cover of the cleanout port so that it is airtight.

3. Fill the hopper with wood fuel, and tamp the fuel down lightly. Either leave the lid completely off the fuel hopper, or adjust the opening around the lid to a 3/4-in. (or larger) clearance.

4. Close the carburetor's air control valve and remove the cover from the blower exhaust on top of the filter unit. Start the blower, and let it run for thirty seconds to avoid explosion of residual gas in the system. Then, with the blower still operating, proceed with the next step.

5. Open the ignition port, and ignite a 12- by 12-in. piece of newspaper; with a long stick or wire, push the burning sheet of newspaper into the grate; see Fig. 3-2. Close the ignition port. If no smoke appears at the blower's exhaust port, repeat the start-up sequence from Step (c). If repeated attempts fail, new charcoal should be added to the unit as described in Sect. 3.3, above, and the start-up ignition sequence should be repeated.

6. After a few minutes of smoky exhaust, test the gas at the blower exhaust by safely and carefully attempting to ignite it; see Fig. 3-3. When the gas burns consistently well, stop the blower and replace the cover on the blower exhaust.

7. Open the carburetor's air control valve, adjust the engine's accelerator, and start the engine in a normal manner. Let the engine warm up slowly (two to five minutes). If the engine fails to start or dies repeatedly, restart the blower and repeat the ignition sequence from Step (4).

3.5 DRIVING AND NORMAL OPERATION

Shift gears so as to keep the engine speed (rpm) high at all times. Remember that it is the vacuum created by the pistons that provides the force which moves the gas from the gasifier unit into the engine.

Refill the hopper with wood (as shown in Fig. 3-4) before it is completely empty, but avoid refilling just before the end of engine operation. Periodically shake down the ashes from the grate. If your system is equipped with a gas cooler, drain water from the cooler from time to time.

Under operation in dry weather, the gasifier can be operated without the lid on the fuel hopper. However, when the gasifier unit is shut down the hopper must be covered to prevent air from continuing to burn the wood in the hopper. Under wet-weather operation, the cover must be placed on the fuel hopper, and then lifted up and rotated about 2 in. until the triangular pieces line up with the holes in the support bars. The tension of the screen door springs will then hold the lid closed. See Fig. 3-5 for clarification.

3.6 SHUTTING-DOWN THE GASIFIER UNIT

When shutting down the gasifier unit, turn off the ignition switch and open the carburetor's air control valve for ten seconds to relieve any pressure from within the system. Then, completely close the air control valve, and place the cover tightly on the fuel hopper. When restarting after a short stopover, let the engine warm up briefly. After longer stops (up to one hour), tamp down the wood lightly and try to use the blower for restarting without relighting the wood fuel. After very long stops (over two hours) the charcoal must be ignited again.

3.7 ROUTINE MAINTENANCE

Periodically check all nuts on the gasifier unit, the fuel hopper, the filter unit, and the carburetor for snugness; check all penetrations and fittings for airtightness. In addition, perform the following maintenance activities as scheduled:

3.7.1 Daily Maintenance

Open the ash cleanout port of the gasifier housing drum and remove the ashes after shaking the grate for at least thirty seconds. Replace the cover of the port after coating the threads with high-temperature silicone to ensure airtightness. Open the drain tube at the bottom of the filter container and allow any liquid condensate to drain out; remember to close the drain tube when finished.

3.7.2 Weekly Maintenance (or every 15 hours of operation)

Clean out the gasifier housing drum, the fuel hopper, and the filter. Rinse out the piping and connections to and from the filter. Replace the wood chips inside the filter. (The used wood chips from the filter can be dumped into the fuel hopper and burned to produce wood gas.) Use high-temperature silicone on all pipe connections and on the filter lid to ensure airtightness.

3.7.3 Biweekly Maintenance (or every 30 hours of operation)

Make sure that all pipe connections are secure and airtight. Check and tighten all mounting connections to the vehicle chassis. Check for rust on the outside of the gas generator housing drum, especially on the lower region. Coat with high-temperature protective paint as necessary.

3.8 OPERATING PROBLEMS AND TROUBLE-SHOOTING

A discussion of problems and their related causes and cures is contained in the trouble-shooting guide of Table 3-1. Many operational problems can be traced to failure to maintain the airtightness of all piping connections and fittings; the piping should be routinely checked to prevent such problems.

3.9 HAZARDS ASSOCIATED WITH GASIFIER OPERATION

Unfortunately, gas generator operation involves certain problems, such as toxic hazards and fire hazards. These hazards should not be treated lightly; their inclusion here, at the end of this report, does not mean that these hazards are unimportant. The reader should not underestimate the dangerous nature of these hazards.

3.9.1 Toxic Hazards

Many deaths in Europe during World War II were attributed to poisoning from wood gas generators. The danger of "generator gas poisoning" was one of the reasons that such gasifiers were readily abandoned at the end of World War II. It is important to emphasize that "generator gas poisoning" is carbon monoxide (CO) poisoning. Acute "generator gas poisoning" is identical with the symptoms that may develop if a heating stove damper is closed too early, or if a gasoline vehicle is allowed to idle in a poorly ventilated garage. Table 3-2 shows how poisoning symptoms develop according to the concentration of carbon monoxide in breathable air. It is important to note that rather brief exposures to very small concentrations of carbon monoxide result in undesirable physiological effects.

In case of carbon monoxide poisoning, first aid should consist of the following procedures:

1. Move the victim quickly out into the open air or to a room with fresh air and good ventilation. All physical exertion on the part of the victim must be avoided.

2. If the victim is unconscious, every second is valuable. Loosen any tight clothing around the neck. If breathing has stopped, remove foreign objects from the mouth (false teeth, chewing gum, etc.) and immediately give artificial respiration.

3. Keep the victim warm.

4. Always call a physician.

5. In case of mild carbon monoxide poisoning without unconsciousness, the victim should be given oxygen if possible.

3.9.2 Technical Aspects of "Generator Gas Poisoning"

Generator gas poisoning is often caused by technical defects in the functioning of the gas generator unit. When the engine is running, independent of the starting blower, the entire system is under negative pressure created by the engine's pistons; the risk of poisoning through leakage is therefore minimal. However, when the engine is shut off, formation of wood gas continues, causing an increase of pressure inside the generator unit. This pressure increase lasts for approximately 20 minutes after the engine is shut off. For this reason, it is not advisable to stay in the vehicle during this period. Also, the gas generator unit should be allowed to cool for at least 20 minutes before the vehicle is placed in an enclosed garage connected with living quarters. It should be emphasized that the gas formed during the shut-down period has a carbon monoxide content of 23 to 27% and is thus very toxic.

3.9.3 Fire Hazard

The outside of a gas generator housing drum may reach the same temperature as a catalytic converter on today's automobiles. Care should be taken when operating in areas where dry grass or combustible material can come into contact with the housing drum of the gas generator unit. If a gas generator unit is mounted on a personal car, bus, van or truck, a minimum 6-in. clearance must be maintained around the unit. Disposal of ashes must only be attempted after the unit has cooled down (to below 150°F). Such residue must be placed away from any combustible material and preferably be hosed down with water for absolute safety.

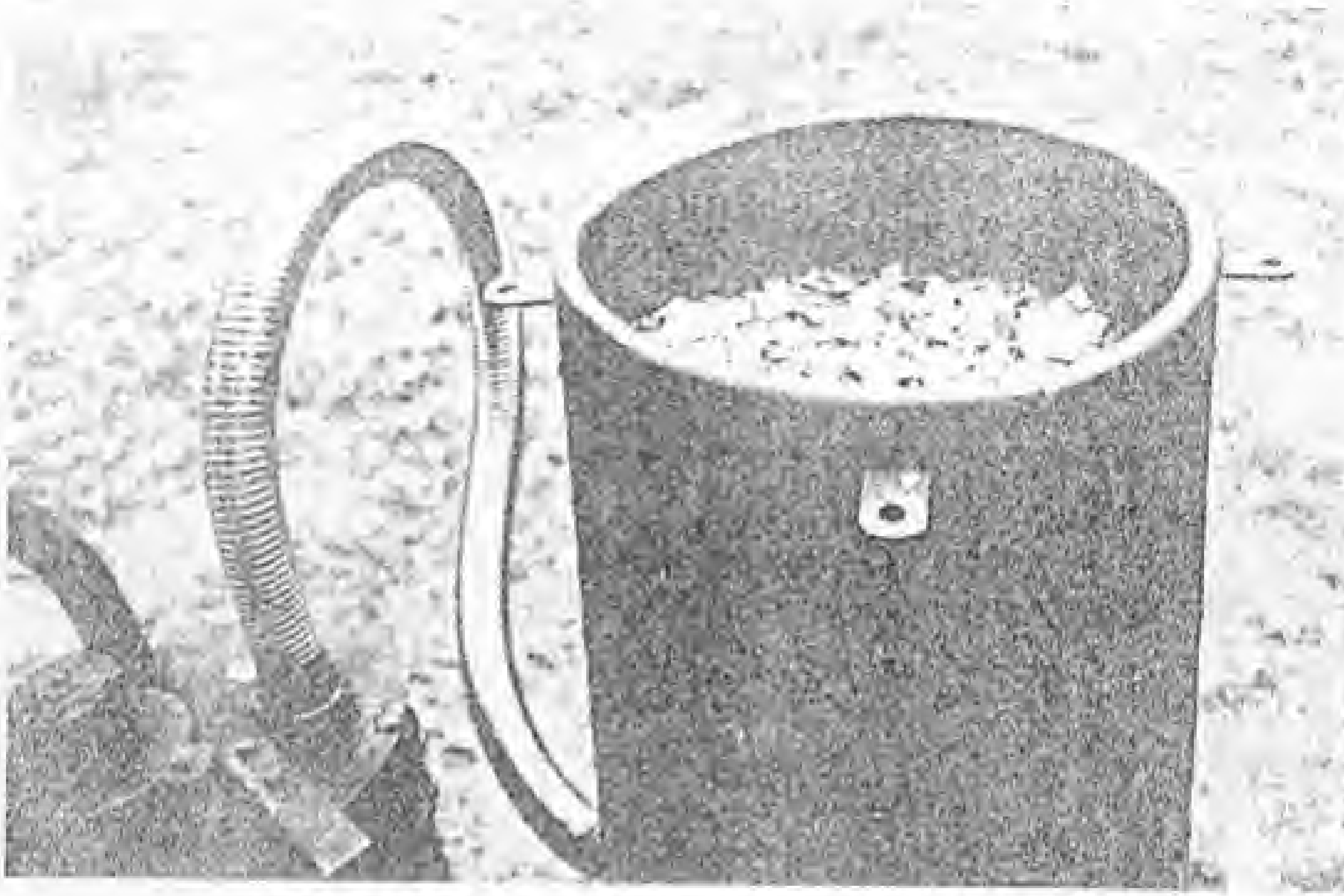


Fig. 3-1. Virtually all varieties of wood chips can be used for fuel. (Minimum size for this 6-in. firetube unit: 3/4 by 3/4 by 1/4 in.; maximum size: 2-in. cubes.)

Table 3-1. Trouble shooting your wood gas generator

Trouble	Cause	Remedy
Start up takes too long.	1. Dirty system or clogged pipes.	Clean the gasifier unit and all connecting piping.
	2. Blower is too weak.	Check the blower and test the battery's charge.
	3. Wet or poor quality charcoal.	Check charcoal and replace or refill to proper level.
	4. Wood fuel bridges in the fire tube.	Lightly tamp down the wood fuel in the hopper and fire tube or replace the fuel with smaller-sized chips.

Fig. 3-2. Ignite a single piece of newspaper to start the gasifier unit. Push the flaming newspaper through the ignition port and directly into the grate. (At the right of the photo, note the battery which is operating the blower atop the filter unit.)

Engine will not start.	1. Insufficient gas.	Use the blower longer during start up.
	2. Wet wood fuel.	Vent steam and smoke through the fire tube and fuel hopper for several minutes.
	3. Incorrect fuel-air mixture.	Regulate the carburetor's air control valve for proper mixing.
Engine starts, but soon dies.	1. Not enough gas has been produced.	Use low RPM while starting engine and do not rev engine for several minutes.

	2. Air channels through fire tube.	Tamp down wood fuel lightly in hopper. Do not crush charcoal above the grate.
Engine loses power under load.	1. Restricted gas flow in piping.	Reduce air mixture valve setting. Check for partial blockage of unit or piping.
	2. Leaks in system.	Check all covers and pipes for air tightness.

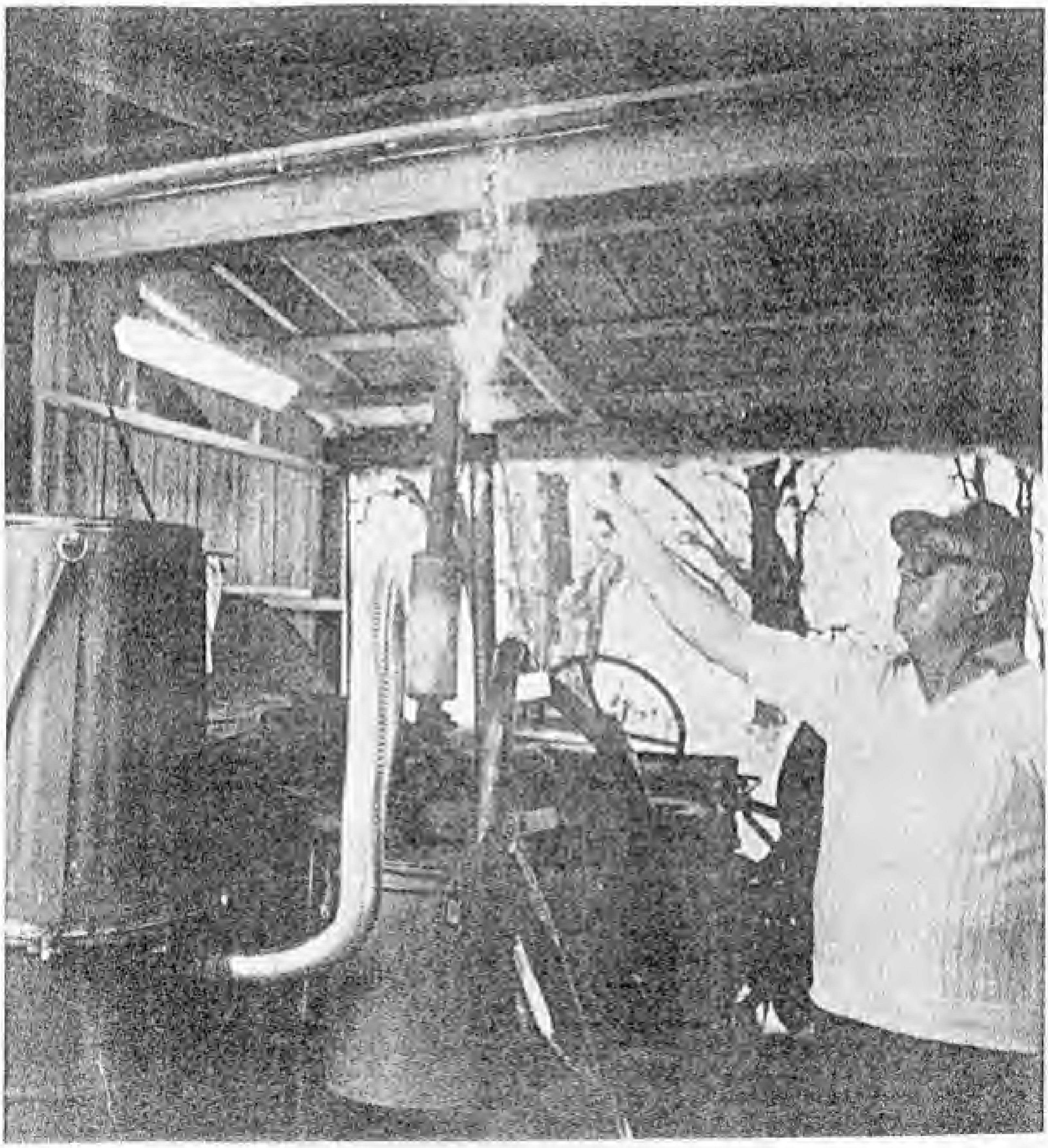


Fig. 3-3. Igniting the exhaust gas will demonstrate that the gasifier unit is working properly.

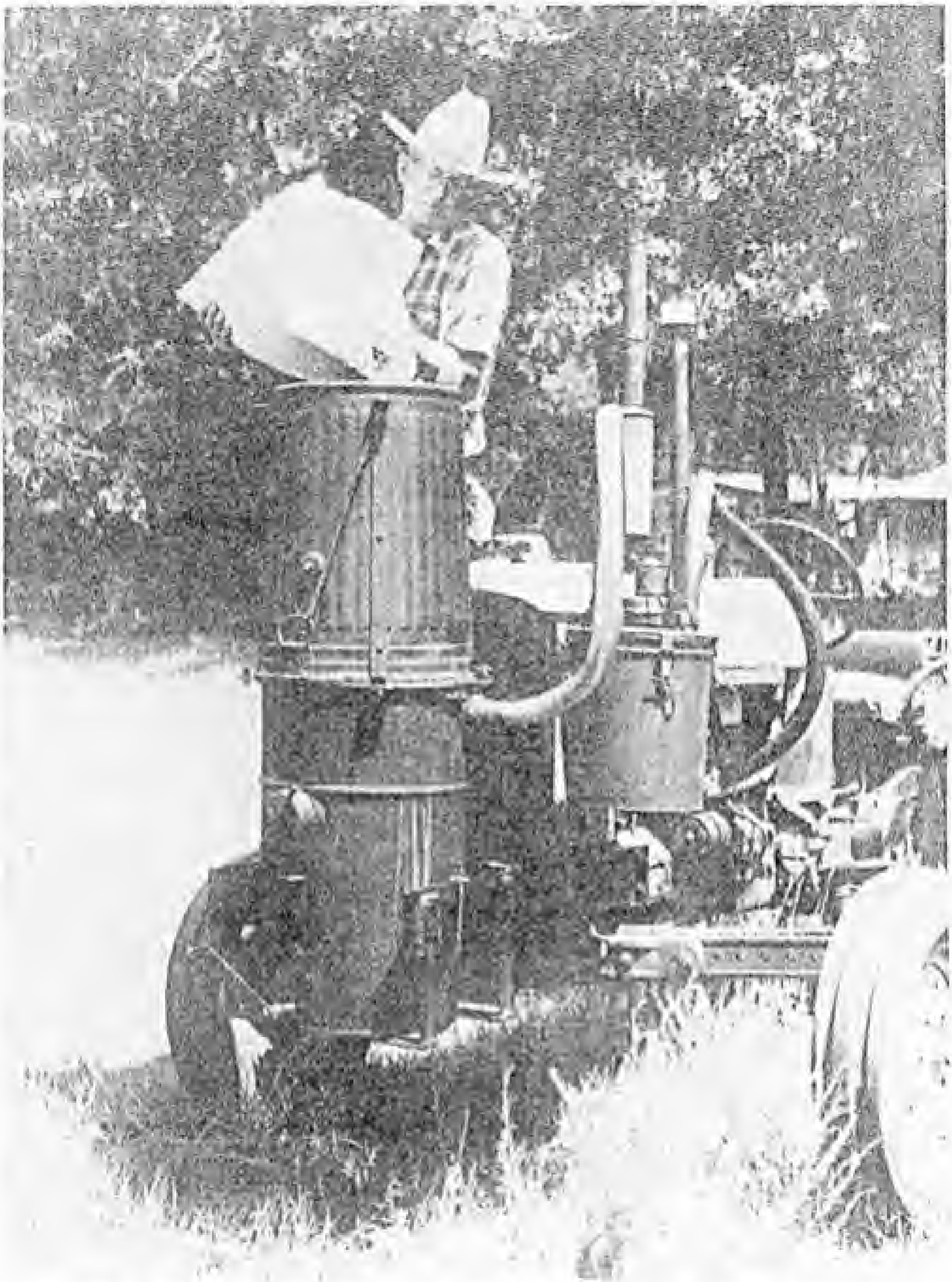


Fig. 3-4. Refill the fuel hopper before it becomes two-thirds empty.

Table 3-2. Effects of breathing carbon monoxide

Carbon monoxide content of inhaled air (%)	Physiological effects
0.020	Possible mild frontal headache after two to three hours.
0.040	Frontal headache and nausea after one to

	two hours; occipital (rear of head) headache after 2.5 to 3.5 hours.
0.080	Headache, dizziness, and nausea in 45 min; collapse and possible unconsciousness in two hours.
0.160	Headache, dizziness, and nausea in 20 min; collapse, unconsciousness and possible death in two hours.
0.320	Headache and dizziness in 5 to 10 min; unconsciousness and danger of death in 30 min.
0.640	Headache and dizziness in 1 to 2 min; unconsciousness and danger of death in 10 to 15 min.
1.280	Immediate physiological effect; unconsciousness and danger of death in 1 to 3 min.

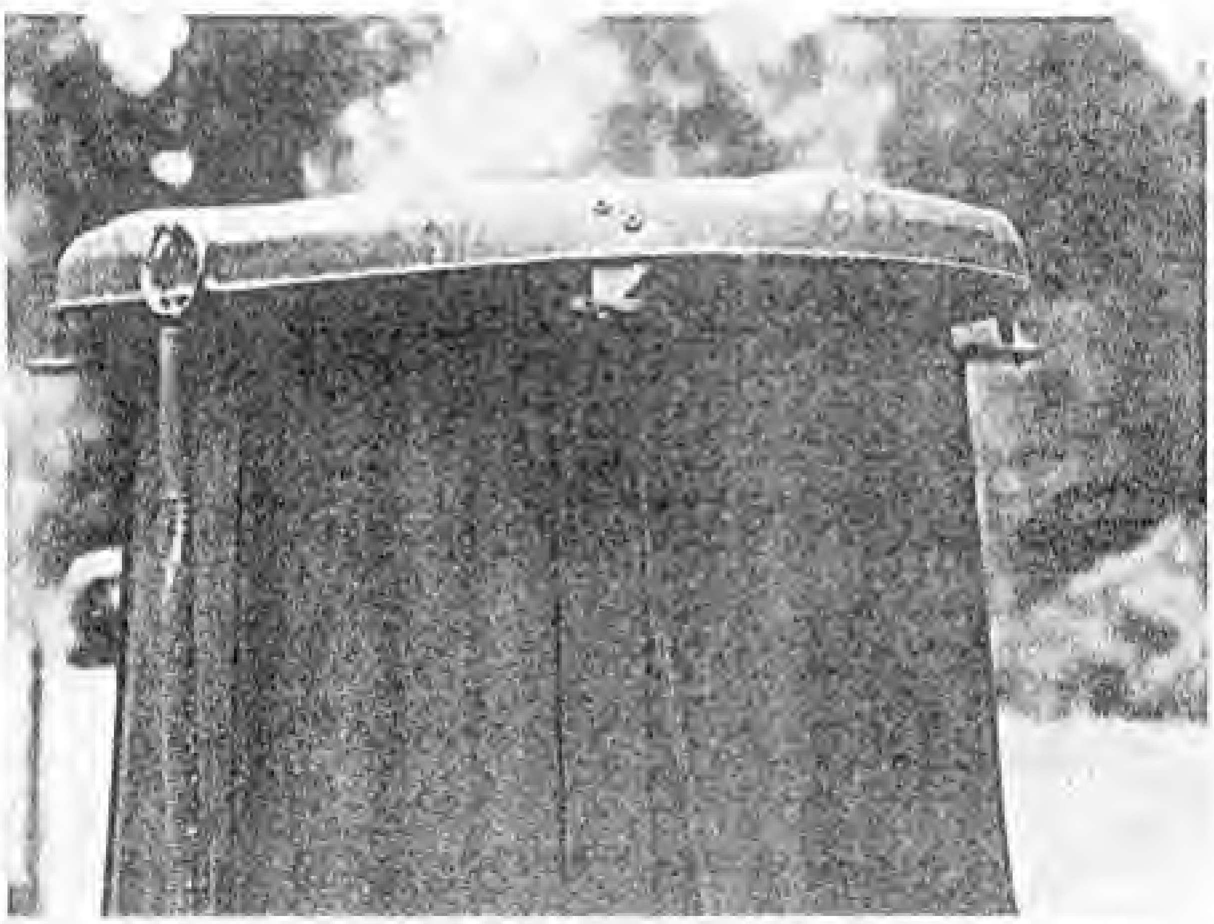


Fig. 3-5. The lid must be used to cover the fuel hopper in wet weather or when shutting the unit down.

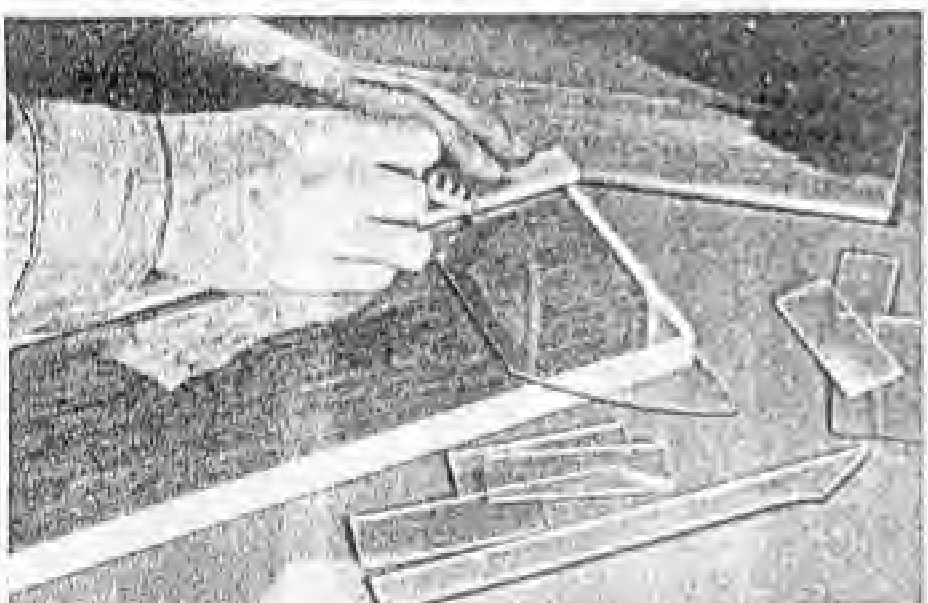
SHORT CUTS FOR THE Amateur Microscopist

Here Are Some Ideas That Your Fellow Hobbyists Have Found Useful To Save Money on Equipment and Supplies, and To Increase Their Instruments' Power

POPULAR SCIENCE MONTHLY
APRIL, 1938

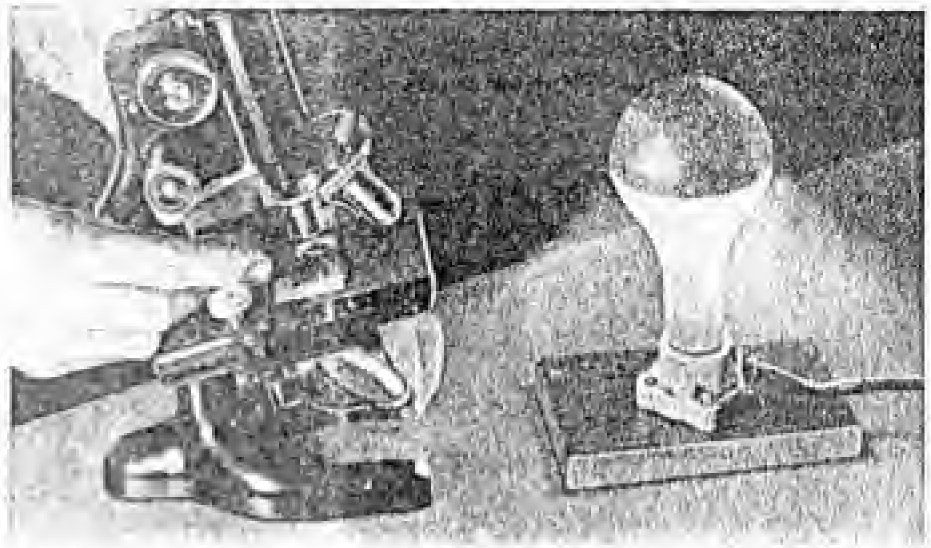
By MORTON C. WALLING

Clear lacquer or varnish is a satisfactory substitute for balsam in mounting many kinds of specimens for examination



With a glass cutter and a homemade jig, you can make your own slides from scraps of single weight window glass. Details of the jig construction are given in the drawing at the bottom of this page

Very thin cells are made by punching holes in cover glasses. This is done by cementing the cover to a metal strip provided with a hole of the desired size, and breaking through the glass, as above



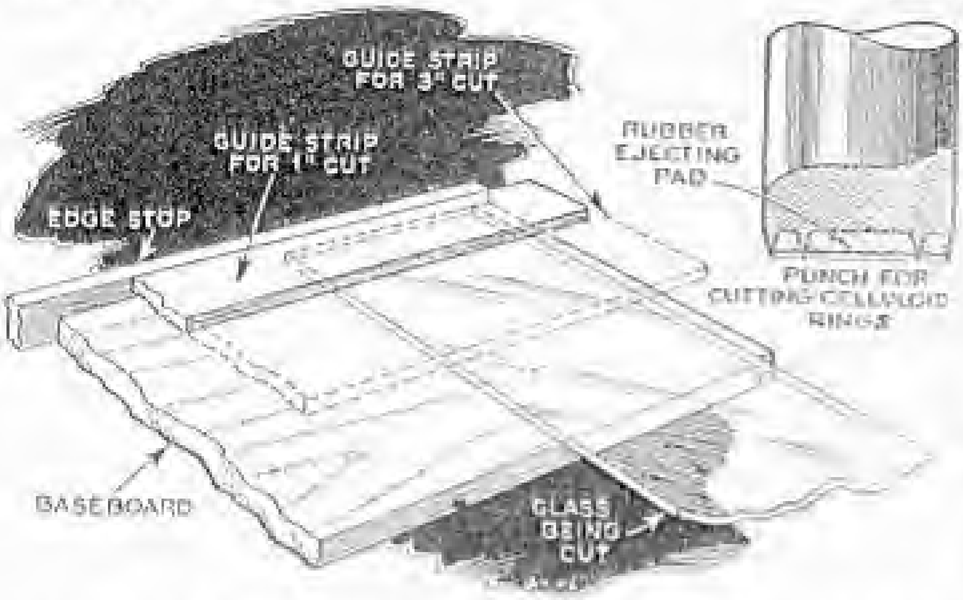
Using one of the new silvered lamps as a microscope illuminator

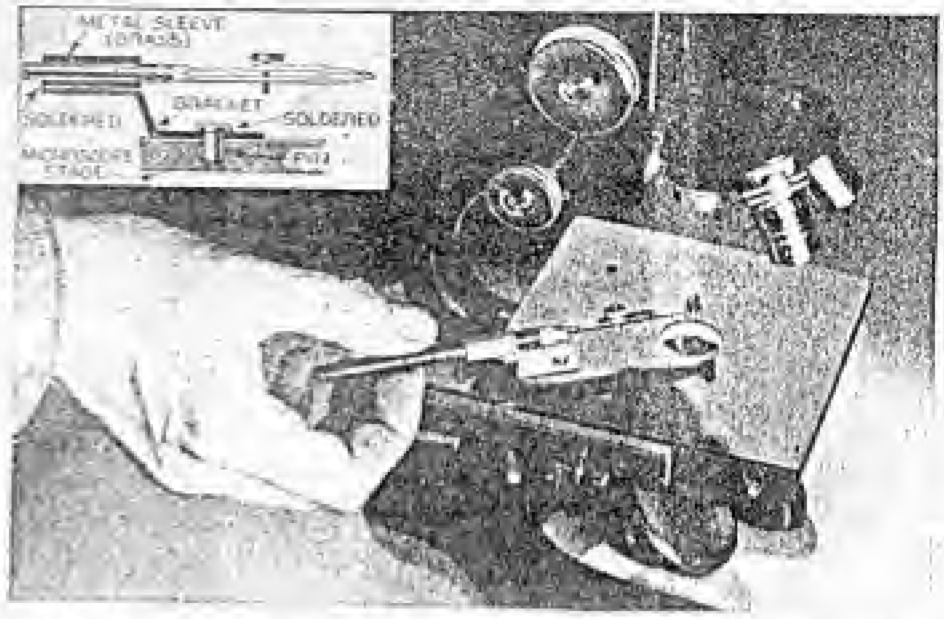
WHETHER by inclination or by necessity, the average microscope hobbyist is an ingenious person. Whenever he can, he employs inexpensive short cuts and timesaving tricks. From junk-box odds and ends he creates needed tools and instruments. With common household articles he reproduces the feats of laboratory technicians. Much of the fun of working with a microscope is in these side-line activities. In the belief that amateurs can profit by knowing what others are doing, I shall describe several short cuts that will not only save money or time but will increase the capabilities of the microscope itself.

Among the absolute necessities in this game of looking at tiny things are the glass slides upon which specimens are mounted. The standard size is 1 by 3 in., although other sizes, particularly larger ones, are employed when necessary. Good-quality manufactured slides cost about a dollar for half a gross. You can make them for yourself, simply by cutting them from scraps of single-weight window glass which the local hardware man probably will give you gladly. Any other flat glass, such as washed-off photographic plates, will do as well.

The trick of making slides is in the cutting. For this you will need a glass cutter (a ten-cent one will do), and a cutting board or jig. Obtain a piece of flat lumber of any convenient size, say ¾ by 12 by 15 in. Along one end nail a strip of wood about 1/16 in. thick, and ½ to 1 in. wide. Along one side nail a similar strip about ¼ in. thick. These serve as stops against which the glass rests; and they must be exactly at right angles to each other. Next cut two wooden strips about ½ in. thick, as long as the baseboard, and of a width that will permit you to make a mark with the glass cutter exactly 1 and 3 in. respectively from the edge. These strips are cutting guides. Their exact width depends on the final treatment of the slides. If you want to grind the edges smooth on an iron plate charged with wet abrasive powder, you should cut the slides a bit oversize, to allow for grinding. If you do not intend to grind the slides, you can cut them exactly to size and eliminate sharp edges by binding them with gummed paper.

Cover glasses may be an item of considerable expense to the amateur. In some cases, substitutes will serve just as well as the commercial article. For instance, pieces of mica about the thickness of a sheet of typewriter paper can be used. Scrap mica can be obtained from hardware stores that service stoves, from electric shops that repair motors, or from the caps of burned-out fuse plugs. Being laminated in structure, mica can be split to any desired thinness. It is easily





A draftsman's ruling pen mounted on the stage for holding insects under the lens. The easily made holder, illustrated in the sketch, allows a specimen to be rotated or moved back and forth freely

cut with a knife or shears. You might experiment, also with pieces of cellulose film or similar transparent material for covering objects mounted in balsam or other nonliquid mediums.

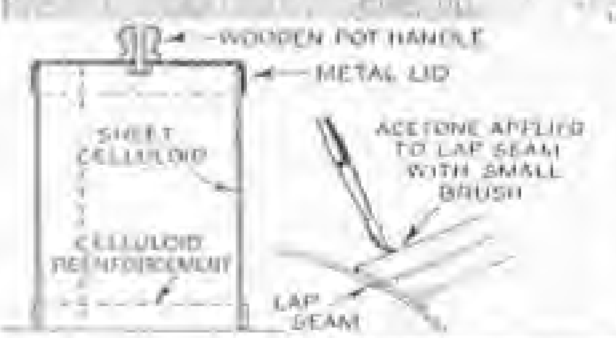
All microscope subjects are not of extreme thinness. It often is desirable to mount whole insects and the like, for study at low and moderate powers. Even such tiny objects as nematodes are not absolutely lacking in thickness. To provide space for such specimens under cover glasses, it is customary to employ cells. These are simply little chambers built in the centers of standard slides.

One of the easiest kinds of cells to make consists of a celluloid washer cemented with balsam to the slide. You can cut the washers with a sharp knife, with a pair of sharp-pointed dividers, or with punches. Punches are probably the most convenient. You can purchase in some localities large-size leather punches of various diameters. Obtain one of approximately the same diameter as the cover glass, and one somewhat smaller. Even more convenient is a punch that will cut both inside and outside circles at one blow of the hammer.

If the washers refuse to lie flat after cutting, simply lay them on a sheet of glass and let a drop of acetone flow under them to eat away the thicker parts. Acetone dissolves celluloid, so do not use too much. Gentle pressure can be applied by laying a sheet of glass on the washers, if necessary. When dry, the washers will separate from the glass.

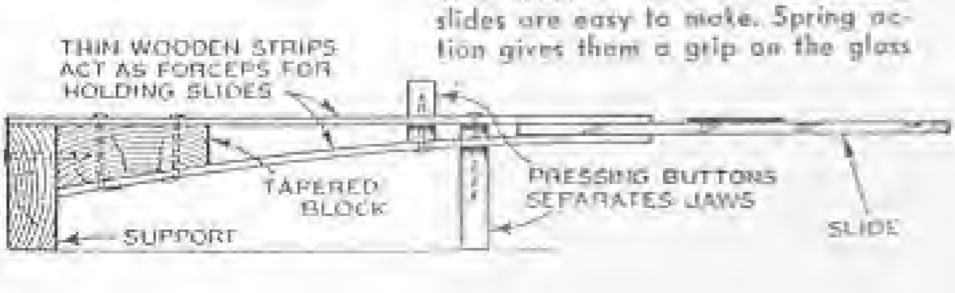
Sometimes it is desirable to use glass washers for making cells. Deep cells are made by drilling holes in pieces of glass of the desired thickness. This is a tedious process involving the use of a brass tube in a drill-press chuck and No. 80 or 100 carbon-silicon abrasive or aluminum oxide, wet with water or turpentine, beneath the tube as a cutting agent.

Very thin cells, however, can be made easily by punching holes in cover glasses. Such glasses are very brittle, and must be handled carefully, especially after being perforated. First drill a hole of the desired size in a flat piece of brass, aluminum, or other metal. Remove any burr from the edges with a file. Heat the metal and coat the area immediately surrounding the hole with sealing wax. While the wax is melted, lay the cover glass on it, centering it with respect to the hole, and let it cool. Now, with a small rat-tail file, you can puncture the glass over the hole, and file it flush with the edges of the metal. Again melt the wax, which was used to keep the glass from breaking beyond the hole, and carefully slide the glass washer off the plate. Remove the wax



Handy bell jars are made from pieces of celluloid joined together with acetone. Inset shows how photographic film can be stripped of gelatin for use in this way

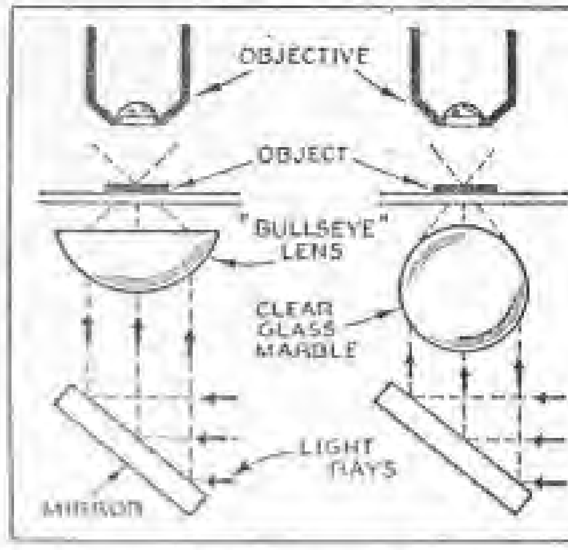
WOODEN TWEEZERS for holding slides are easy to make. Spring action gives them a grip on the glass



The bullseye lens from an ordinary flash light will serve as a substage condenser if mounted under the stage as pictured above

with alcohol, lacquer thinner, or carbon tetrachloride, which is contained in most fireproof cleaning fluids. Use Canada balsam to cement such cells between slide and cover glass.

If you are caught sometime without your usual balsam or other standard mounting mediums, try clear varnish or lacquer. A. W. Cooper, a POPULAR SCIENCE MONTHLY reader living in Bozeman, Mont., reports that he has had better luck with clear varnish than with balsam for such objects as insect scales, hairs, and pollen grains, because the index of refraction is more favorable. He also finds clear lacquer excellent for general work, and reports that it is much used at Montana State College for algæ and other delicate plant and animal tissue. The lacquer sets quickly and has a favorable index of refraction. Passing through high-strength alcohols is unnecessary, which is a distinct advantage with delicate specimens that shrink easily. Tissues are carried through various grades of alcohol in the usual manner, to 85% or 90% strength. Then they are transferred to lacquer thinner, which clears them and removes any remaining water. From the thinner, the specimens are transferred to the lacquer.



How a flash-light lens or a clear glass marble acts as a condenser to concentrate light

As a suggestion, tissues might be dehydrated with dioxan instead of alcohol, and transferred directly to the thinner or even to the lacquer itself, with a considerable saving of time.

You will find ordinary varnishes (preferably the quick-drying or four-hour types) and lacquers excellent for building shallow cells on a spinning table, and for ringing cover glasses to improve their appearance and seal their edges. Various colors can be used to dress up the slides.

AMONG the newer sources of illumination of interest to microscopists are the new silvered lamps designed for use with bowl-type indirect-lighting fixtures. These are standard incandescent lamps with the spherical half of the bulb opposite the base silvered like a mirror and provided with a protective coating. The silvering acts as a reflector to direct the rays in the general direction of the base. One of these placed in a socket fastened to a block of metal or wood makes an excellent microscope lamp. The silver coating prevents light from passing upward toward the eyes of the observer, and at the same time directs it downward toward the microscope mirror. Since no housing is necessary, ventilation problems are solved automatically.

If electricity is not available you will find an ordinary oil lamp one of the best of light sources. Place it so that the flat side of the flame is picked up by the microscope mirror, and arrange a shade to keep direct rays from the eyes. Because of its large area and uniform luminosity, an oil-lamp flame is superior to many newer types of light for some kinds of observation.

Did you know that a draftsman's ruling pen makes an excellent clamp for holding an insect beneath the lens of a microscope? The jaws of the pen grasp the specimen like tweezers, and are held together by tightening the adjusting screw. The pen should be mounted so that it can be revolved and moved back and forth. One way of doing this is to fasten a short length of tubing parallel to the microscope stage, and with its center line a fraction of an inch above it. Slide the pen handle inside the tube, making the fit snug enough to hold the pen in any position.

WOODEN forceps are handy for holding glass slides, and are easy to make. Obtain a pair of flat, thin strips of wood, like the ones physicians use for depressing the tongue, and join them at one end with a wooden or metal block tapered slightly so that the other ends of the strips press against each other. Drill holes as shown in the drawing, and attach a small screw or wooden button to the inside surface of each strip so that it will project through the hole in the other strip. By pressing the buttons simultaneously with your fingers, you force the jaws of the forceps apart to insert a slide. One button can be fashioned to form a foot, so that the forceps will rest firmly on a flat surface.

Color filters can be made by dyeing the gelatin of bleached-out photographic film. If you can obtain some undeveloped film—most photographic-supply shops have some outdated film on hand that they will give away or sell very cheaply—you can bleach it out by immersing it for fifteen minutes in a standard hypo fixing bath. Then wash it for about twenty minutes in running water.

YOU can dye the gelatin coatings of the film with any of the aniline microscope stains, or with one of the various photographic dyes available. Dry, and mount in any convenient manner.

Since photographic film is damaged by heat, and may be ignited, it should be used cautiously with strong sources of light such as an arc or a projection bulb. Better for this purpose are filters made by dyeing the gelatin coatings on bleached-out lantern slides or glass-plate negatives.

Ordinary celluloid, not coated with gelatin, can be colored with dyes dissolved in alcohol and acetone, with acetone predominating. Experiment will indicate whether the results are satisfactory for microscope filters.

The action of acetone in welding together two pieces of celluloid or acetate film suggests a way of making small bell jars and other devices of use in microscopy. You can use washed-off photographic film, the gelatin coating of which can be removed by immersing it for fifteen minutes in a warm bath of 5% sulphuric acid; or you can employ sheet celluloid obtainable from automobile-supply stores. Simply cut the material to the shape desired, and weld the joints and seams by holding the pieces together and placing acetone, with a brush or dropper, so that it flows between them by capillary action. The acetone dissolves the surfaces of the celluloid and permits them to weld together in a few seconds.

THE work should be allowed to dry thoroughly for a day, before it can be considered permanent. Instead of acetone alone, you can employ a standard motion-picture film-splicing cement, which consists generally of celluloid dissolved in solvents such as acetone and ether. Celluloid should be employed only for articles to be used where there is no danger of their being set on fire. Cellulose acetate (safety film) is preferable to ordinary celluloid because it burns less readily. Either of the materials can be bent to permanent shapes by heating to about the boiling point of water (NOT with a flame!) to render them pliable. Hold them until cool.

Objects mounted on a glass slide may be extremely difficult to see by ordinary methods. This often is a result of the refractive index of the object being about the same as that of the mounting medium. There are various ways of making such objects—a snail's tongue for example—easier to see. One, of course, is to use polarized light, which works wonders with cellu-

lose materials and a great many others. Another is to employ dark-field illumination. However, a simple method that often works well with the amateur microscope is to use oblique illumination. This can be produced by inserting a disk of cardboard or other object into the light beam between mirror and stage, so that only a portion of the beam passes at an angle from the mirror to the object. Larger microscopes having a substage ring for holding filter glasses and dark-field stops can be fitted with cardboard disks having holes or notches cut near the margins. Although a single hole usually is sufficient, combinations of two or more can be worked out to give various effects.

AND here is a fine hint for the owner of a microscope that does not have a substage condenser for concentrating light on the object: Try placing a large, clear-glass marble directly beneath the hole in the stage, so that it comes very close to the bottom of the slide. The marble, acting as a short-focus condensing lens, increases illumination. Small bullseye lenses employed on some types of flash lights can be used in a similar way.

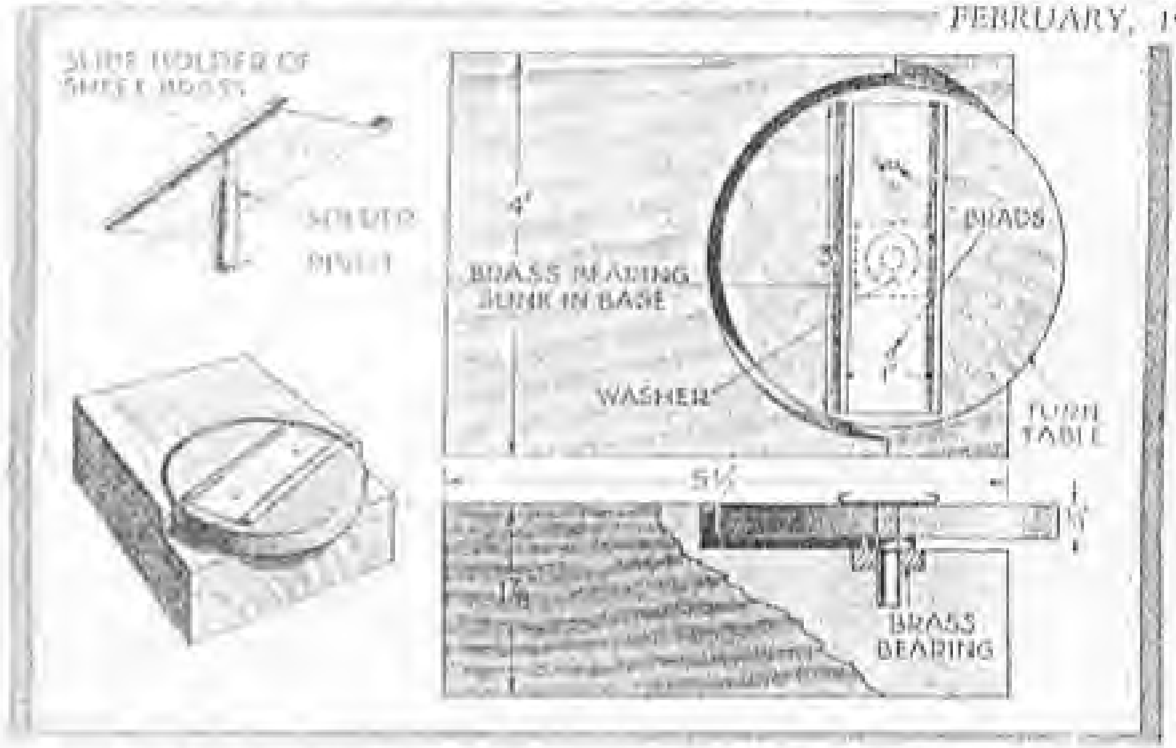
Creating New Worlds with YOUR MICROSCOPE

By BORDEN HALL

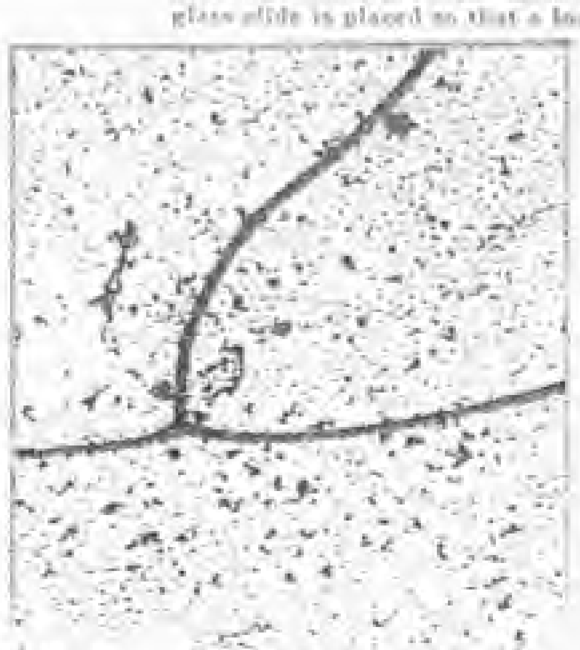
Specimens, sealed beneath cover glass on a slide, can be preserved as part of your collection

POPULAR SCIENCE MONTHLY FEBRUARY, 1933

Photo right shows how a mosquito looks when magnified eleven times



Drawings above show the manner of preparing a turntable for yourself upon which a glass slide is placed so that a low wall of shellac can be built up to inclose specimen



Above, before a slide is used, it should be cleaned with alcohol as shown. At right, wing of house fly as seen under a microscope. Dots are dust particles

PRACTICALLY boundless and much of it still awaiting the curious eyes of those who would unravel nature's secrets, lies the world you can see only with a microscope.

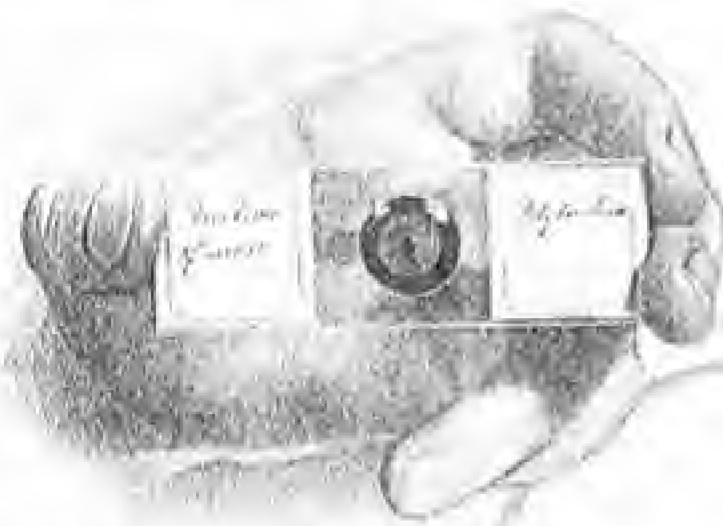
Within his borderless domain, the microscopist can populate little worlds of his own making. From a scene almost as still as death, he can create a world teeming with life. He can bring into being countless millions of tiny creatures not visible to the naked eye.

One way to do this is by what is known as a hay infusion. A few stems of hay are placed in a jar of tepid water and permitted to stand undisturbed in a warm room for about four days. Then some of the water is taken off with a spoon or a medicine dropper and a drop of it is placed upon a slide freshly cleaned with alcohol. When this is done, we shall be amazed to find many weird creatures streaking across our vision. The scene is like a nightmare—a phantom world peopled by strange creatures.

Just as we have brought this strange world

Left, picture shows how an examination of a specimen can be made with the microscope tilted. Above, view of a plant louse magnified 12 times

This photo shows manner of adjusting the shutter under the stage of the microscope



Upper left, view of a commercial slide as prepared by a professional. Above, safety razor blade as seen under a low powered glass

into being, so we can destroy it and its queer inhabitants. Before we commit this master crime, however, we shall need more equipment. It will serve not only for this amazing experiment but will prove useful in many others, so the time used in making it will be well spent.

When specimens are mounted permanently, they are placed between the microscope slide and a thin, button-like cover glass. These transparent covers are fastened to the surface of the slide by a special preparation applied in a circle with a camel's hair brush in the manner to be described.

To do this quickly and easily, we will need a turntable similar to the one shown in the sketches. The base is a piece of trimmed "two by four" recessed to accommodate the turntable proper. The recessing may be done with a sharp knife. Of course, the base also may be made from two pieces screwed together, the toppiece being cut out with a band saw or a coping saw. The solid form of construction, however, is best if the maker has the patience.

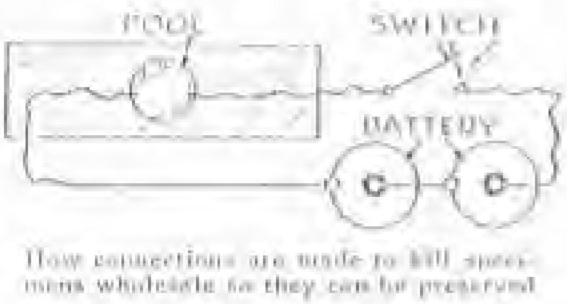
A piece of heavy sheet brass, bent to the dimensions shown, serves to hold the specimen slide and the worker should see to it that the slide will slip in and out easily. A small shaft of brass or iron, (a piece of a large nail or spike will do), soldered to the bottom of the rack forms a pivot. The bearing for this member can be made from a piece of brass drilled to produce a snug fit for a shaft.

The turntable is cut from a well-seasoned piece of quarter-inch wood drilled to receive the shaft, the slide holder being fastened to the turntable with two small brads. When a small washer with a drop or two of oil is placed between the turntable and the base and a coat of shellac is applied to the entire instrument, it is ready for use.

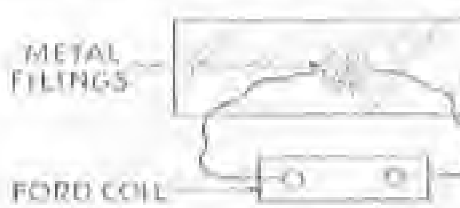
When a slide is placed in the holder and a brush dipped in shellac or other preparation is held near the center of the slide, which is revolved by bringing one finger in contact with the free edge of the turntable, a circle of shellac will be drawn on the glass. By permitting the first coat to dry slightly and adding other coats, a low wall of shellac may be built up to enclose your specimens.

For the wholesale murder we contemplate, we shall need several applications of shellac so that the wall will be high enough to retain several drops of water. The water is taken from the bottle containing the hay and it teems with infusoria.

We murder by electrocution and the drawing on this page makes the method clear. Only two dry cells will be needed with two tiny copper wire terminals immersed in the solution. After the water is placed in the well and the wires are arranged, we focus the microscope and then watch for an opportunity. When the scene looks right and the proper number of bay water denizens are in sight, we throw the switch. Presto! Death stalks the scene with lightning-like rapidity. What had looked like a crowd of people at a country fair is now a scene of utter



How connections are made to kill specimens wholesale so they can be preserved



With this apparatus sparks are made in iron filings and rare displays produced

desolation. We now can study the motionless specks to our heart's desire.

Now, let us leave the realm of biology and follow the by-roads of physics. For the next experiment, we shall need an old Ford spark coil, obtainable for almost nothing from the junk heaps of auto wrecking yards, three dry cells, a microscope slide, and some iron or copper filings. These materials are arranged on the stage of the microscope as illustrated.

After the instrument has been focused, the primary circuit of the coil is closed and a spark is permitted to play among the filings. Instantly we are treated to a sight that will long be remembered. Here we see a display of fireworks that will appall us and if the wires are rearranged in various positions, different effects may be obtained.

Mounting specimens for study is in itself a fascinating task. Perhaps the best object for the beginner is a fly's wing, since it is transparent. Indeed, we may start our work by preparing an interesting collection of different transparent wings—wings from a bee, a mosquito, a wasp, a yellow jacket, a fruit fly, and other common insects.

Specimens must be mounted *absolutely* dry. This does not mean that they should be placed in an oven for a few minutes; the preparation is much more elaborate than that. For this part of our work, we shall need a few ounces of concentrated sulphuric acid, keeping in mind that it is an active corrosive agent that should touch neither the specimens nor our hands. This is placed in the bottom of a large jar. Suspended from the top of the jar on rubber bands (the fumes from the acid will attack ordinary metals) is a small platform of clean glass. The specimen to be dried is placed on this glass and permitted to remain there for about a week. Of course, a number of specimens can be placed on the glass rack at one time. A drying jar of this type is called a desiccator.

WHEN the week has passed, we prepare our slides before the specimens are taken from the desiccator. After clear or white shellac has been applied to the clean slides with the aid of the turntable, they are placed in a warm oven and left there for at least an hour. The object of this layer or circle of shellac is to provide a small specimen chamber between the slide and the clean cover glass. The rim of shellac should be high enough to allow the cover glass to fit neatly in place over the specimen.

Having progressed thus far, we now place our slides back on the turntable, one at a time, and with *tweezers* carefully place the specimens. Then a clean cover glass is set in place in such a way that it will be exactly concentric with the circle of shellac. Next a camel's hair brush filled with thin asphaltum varnish is brought in contact with the outer circumference of the cover glass to seal it to the slide. The seal should be examined closely for leaks as air must not reach the specimen. If it does, the specimen will soon become moldy and discolored and unfit for future display. If a leak is detected, it should be smeared with the sealing compound.

By permitting each successive circle of shellac to dry and applying still another, we can build up chambers or cells sufficiently high to accommodate objects of considerable size. It must be recalled, however, that these objects must be transparent or translucent.

FROM what has been said it must not be thought that only transparent specimens can be viewed in a microscope. That would be stretching it a bit. However, when we want a real intimate view, we must be able to see through the specimen. That does not mean, for instance, that we cannot view a fly's leg under the microscope. We can indeed and it often happens that merely the shadow of an object is intensely interesting. In this category we might mention the edge of a razor which appears like a saw even under low magnification. A pin point, while we cannot see through it, appears blunt and resembles a crowbar when viewed at fifty diameters.

In our gardens we can find countless objects that make interesting sights without much preparation. Plant lice or aphids may be examined alive under the instrument with the assurance that they will stand still for minutes at a time. They appear as weird monsters under low power.

In closing, the writer would like to address a word or two to those who would enjoy this work but who, for lack of time, cannot prepare the specimens. A large variety of specimens, already mounted by professionals, may be purchased from dealers in microscopes. When ordering, however, the amateur should make sure that he does not obtain slides that are beyond the power of his instrument.

Living GERMS from other worlds . . .

. . . brought to Earth by METEORS

By Robert E. Martin

POPULAR SCIENCE MONTHLY APRIL, 1933

SPELLBOUND at a microscope, Prof. Charles B. Lipman, University of California biologist, recently gazed at what he believed to be the first living creatures from another world ever observed. Tiny germs—some round, some rod-shaped—swarmed beneath the lens. Despite their minute size, they were as fascinating to a scientist as any hypothetical man from Mars.

If Prof. Lipman has correctly explained the germs' origin, they came to earth carried by a flaming meteorite from the worlds beyond our planet! Here, after centuries of speculation, seems the first credible indication that life exists outside the earth.

To test the possibility that living things might exist in other worlds, Prof. Lipman acquired a number of stone meteorites that had fallen on the earth. He proposed to grind these to powder and drop the powder in suitable culture media to see whether germs would grow. If so, evidence would be strong that the germs had survived the

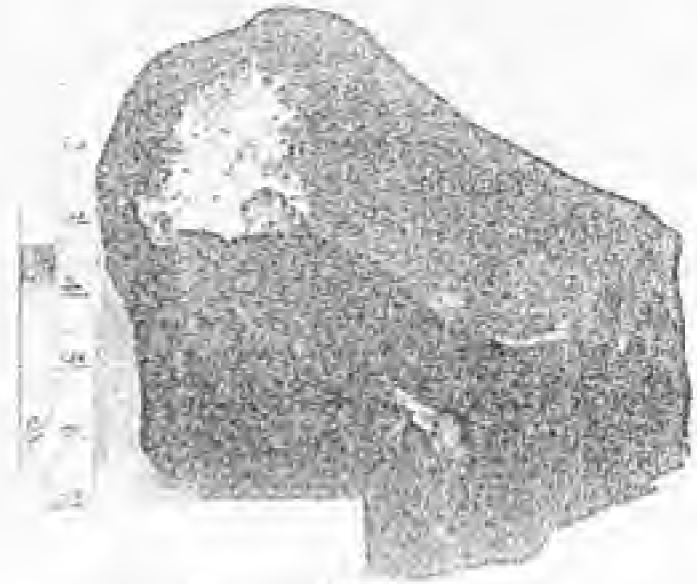
cold of the journey through space, the heat of the flaming meteor when it struck the earth's atmosphere, and the years the meteoric stone had rested on the ground or in a museum case. Of course it would be necessary to take extraordinary precautions to make sure the meteorite was uncontaminated by bacteria from the earth.

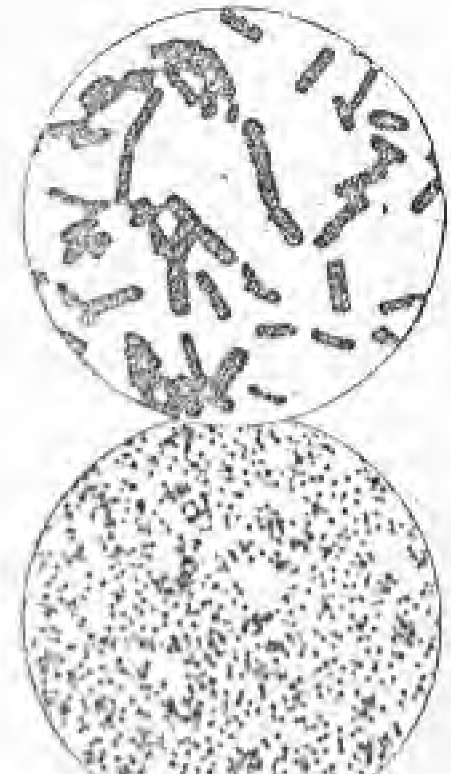
Wearing cheesecloth masks, like those used by surgeons, Prof. Lipman and his helpers sterilized their instruments and at each succeeding step took elaborate precautions to guard against earth-born bacteria, as shown in the illustration at the bottom of page 42. So drastic was this treatment that it probably killed some germs *within* the meteorite as well as outside, yet some survived and grew and reproduced beneath the experimenter's eyes!

So startling is his conclusion that meteorites bring germs to earth, that bacteriologists cannot accept it until it is verified by future independent investigators. Doubts have already been raised. Yet Prof. Lipman himself answers many of them.

A flaming meteor may remain cold inside during its brief plunge to earth, so germs within it might survive; that they can survive passage through the extraordinary cold of outer space is also known, since recent tests at the University of Toronto showed germs could live after weeks of exposure in liquefied helium to a temperature of 450 below zero. Possible contamination from the soil? Some of the meteorites were picked up sterilized immediately after landing upon our earth.

If the germs rode to earth on meteoric stones [illegible] did they come from? Some bacteriologists [illegible] members of our own solar system



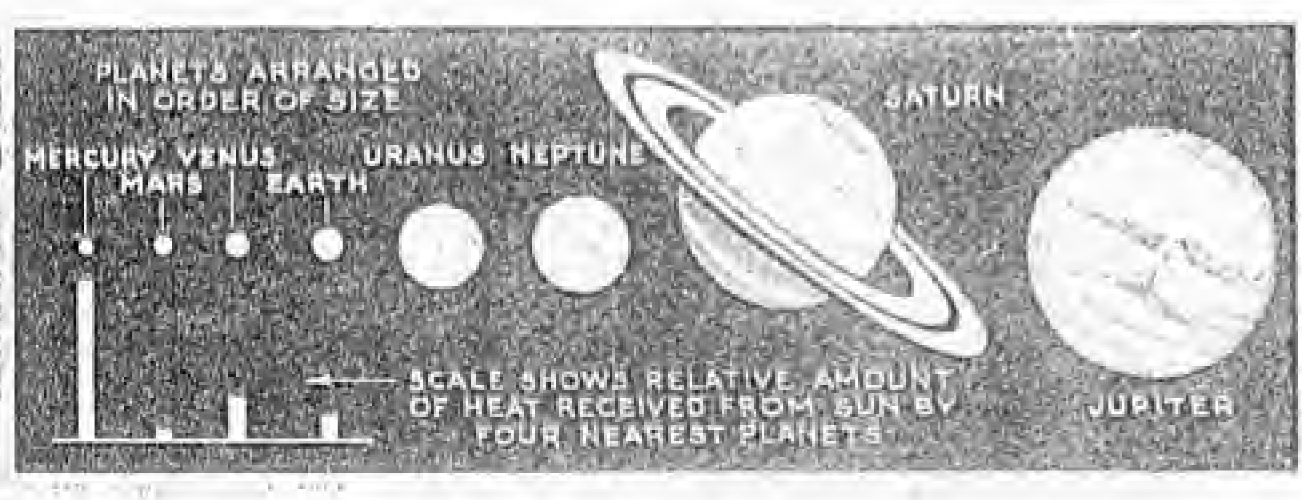


In a fragment of the Modoc meteorite, shown above, Prof. Lipman found living germs. In the circles, right, are two microphotographs of these germs, magnified 1,500 times. The germs [illegible]

DOES LIFE EXIST ON OTHER PLANETS?

Besides the earth, only Mercury, Venus, and Mars, shown on the chart of the planets, are considered capable of supporting life. These planets are being studied to find evidence of an atmosphere and a temperature similar to that on earth. At present, it is thought Mars is the most likely to support forms of animal life

"Meteorites bring with them bacteria from somewhere in space," was the conclusion of Charles B. Lipman, above, after he had made the tests described here



By treating the meteorite as shown below, Prof. Lipman destroyed earth-born bacteria and found germs from other worlds.

others may be strays from space beyond. Other evidence alone limits the absorbing speculation of where life might exist in the universe.

Of the nine planets now known in our own solar system, only the earth, Mercury, Venus and Mars could conceivably support life. The others are too cold, while Mercury may be virtually eliminated as too hot. Venus, recently discovered to have an unbreathable atmosphere, might support creatures adapted to great heat. Mars is the most likely possibility, and recent tests of its temperature and atmosphere show it even more favorable to life than once imagined. There may be thousands of other solar systems like our own, each capable of supporting life and possibly human beings. Any attempt to imagine what sort of creatures inhabit these worlds has always been pure fancy; hence the unusual interest in the germs found by Prof. Lipman.

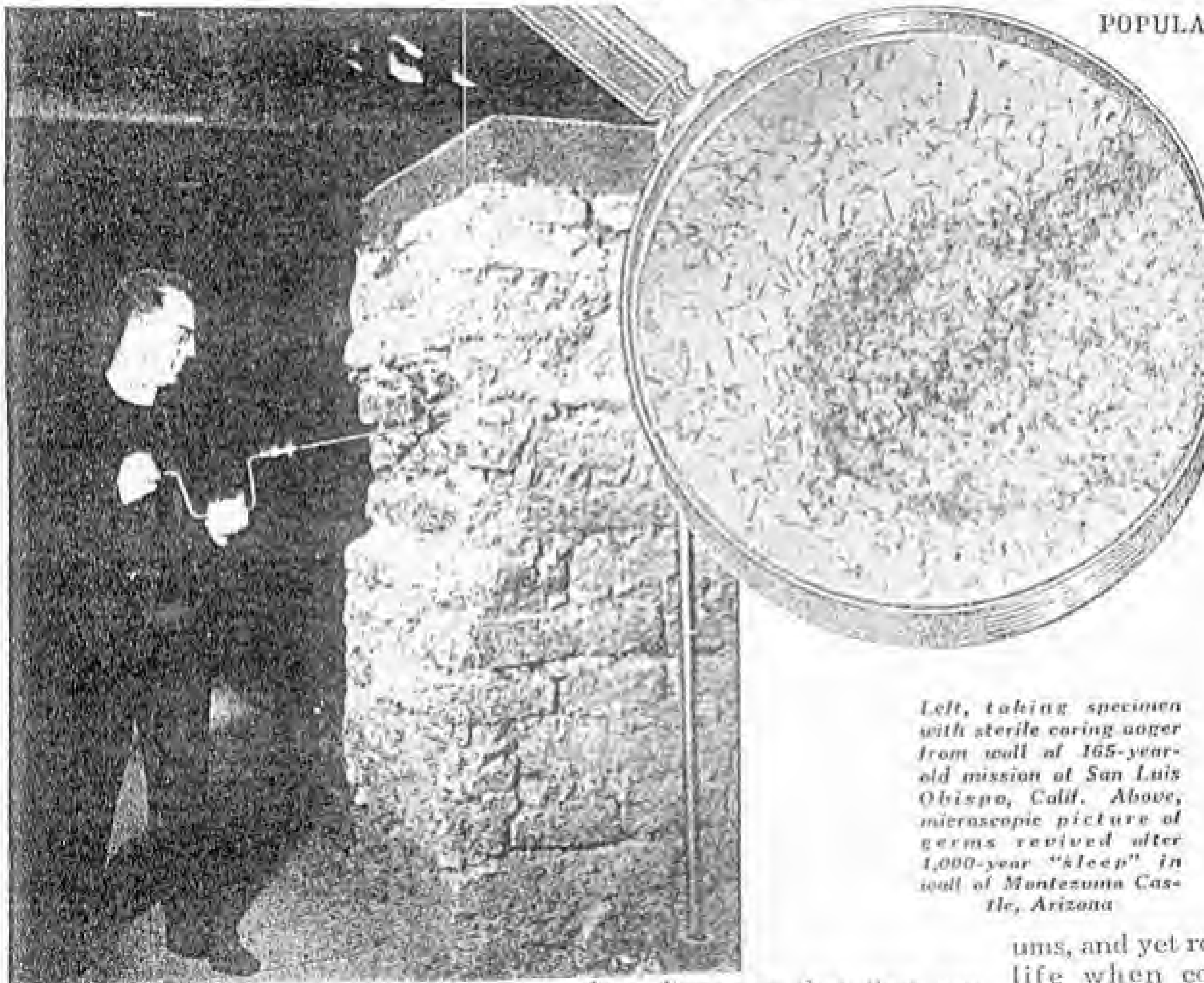
Could they be disease germs? Bacteriologists doubt that possibility; they point out there is less than one chance in a trillion that germs capable of attacking an earth-dwelling being might have evolved on other planets.

Bacteria look alike, but it is possible to identify and classify a new kind by delicate chemical and physiological tests. Dr. Lipman believes most of the germs he has found in meteorites are closely similar to those on earth, if not identical—an observation lending plausibility to the idea that other and higher forms of life outside our planet may be like our own. Tracing such forms of life, from the germs just found, will prove a thrilling adventure for the experimenters of the future, and will open new fields of investigation.

HOW LONG CAN GERMS LIVE?

POPULAR MECHANICS

Feb. 1940



Left, taking specimen with sterile coring auger from wall of 165-year-old mission at San Luis Obispo, Calif. Above, microscopic picture of germs revived after 1,000-year "sleep" in wall of Montezuma Castle, Arizona

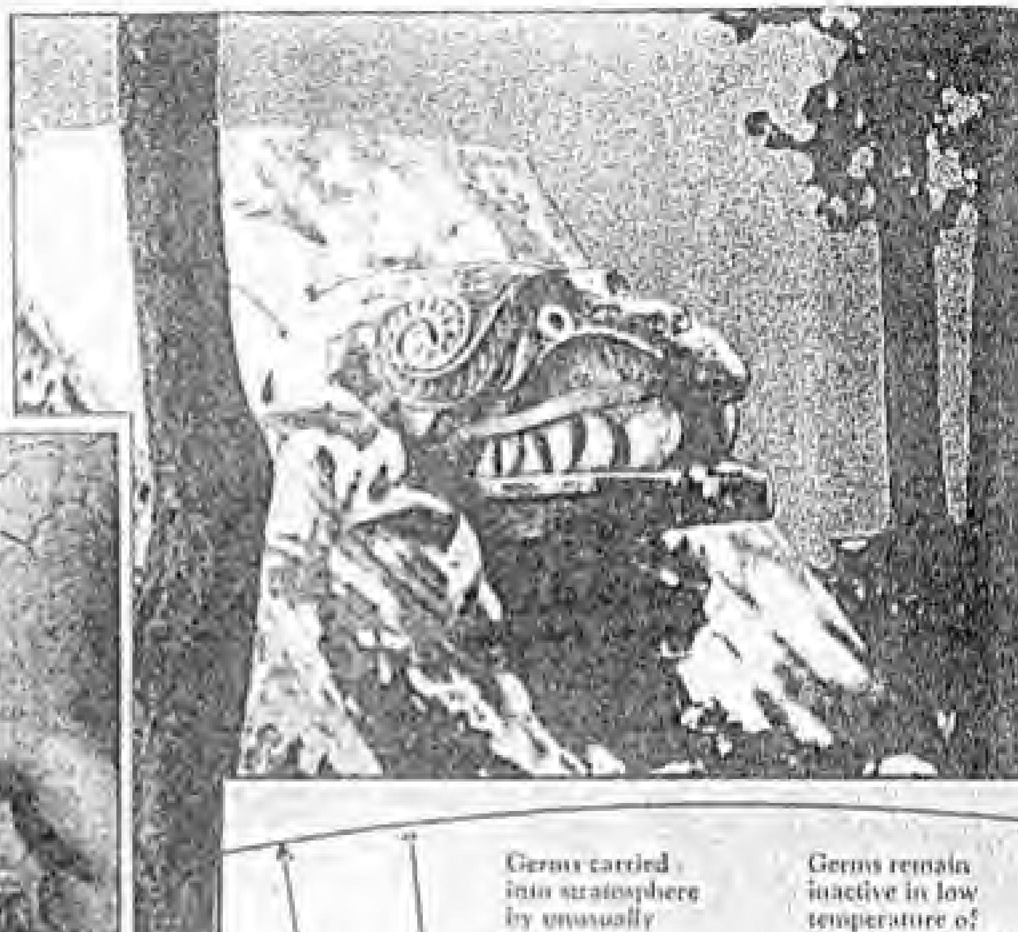
INSIDE the test tube a murky cloud is gathering. A sleep that began before the Egyptian pyramids were built is ending. For 5,000 years organisms have lain dormant, sealed within a thick wall, cut off from light, air, food, or moisture.

These organisms are bacteria and tiny one-celled spores; the startling discovery that they are potentially deathless is the result of the painstaking experiments of a California doctor. And the upshot of it all is that some of science's most intriguing questions are due for new answers.

How long can germs really live? Can living things lie dormant, for centuries, even millenniums, and yet return to normal life when conditions again become favorable? Have great epidemics been caused by disease germs which drifted high in the stratosphere, dormant, but ready to resume their deadly work when a down current of air brought them to earth? These questions have inspired a thousand experiments. The latest of

these, performed by Dr. Ira B. Bartle, and checked by scientists from the universities of California and Pennsylvania, throw new light on this age-old problem.

From deep within an ancient Mexican pyramid, from an old California mission, and from a hundred other ancient structures, Dr. Bartle has gathered material which gives



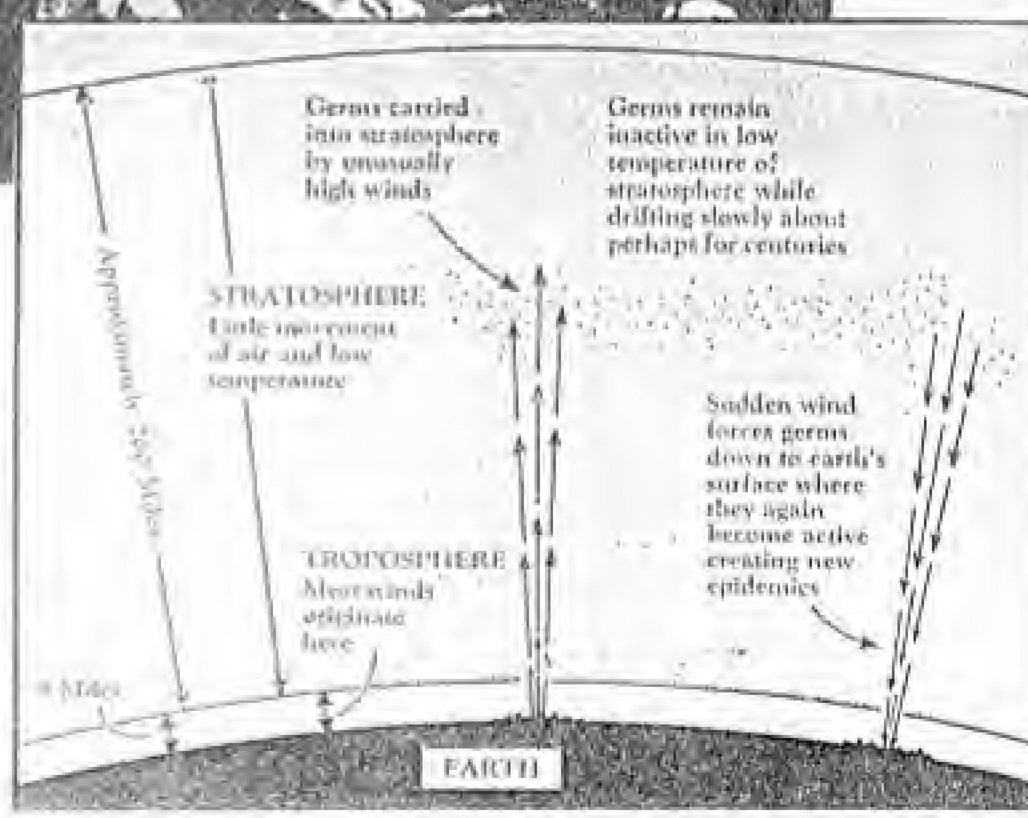
Bacteria were revived from material sealed 5,000 years in Mexican Pyramid of the Sun, right. Below, flaming wall to prevent contamination before boring specimen.

proof that organisms have remained dormant for periods up to 5,000 years. Other experiments indicate they can withstand freezing, that they exist high in the stratosphere where the temperature is seventy degrees below zero.

Years ago Dr. Bartle conceived that it might be possible for single-celled organisms to sink into a dormant state in which they would remain potentially alive. Obviously, the only sure proof would be to find something which once contained bacteria, but which had been protected from further contamination and from growth for an extended length of time.

"When I first told people about my theory," Dr. Bartle admits, "the whole thing sounded crazy—even to me. But although I didn't have much hope of succeeding, I decided to try."

A few blocks from Dr. Bartle's home in San Luis Obispo, Calif., was a Spanish mission built in 1775. Some of the basement walls had been untouched since they were constructed. They were several feet thick, made of sun-baked brick, and dry as a bone. These walls seemed ideal for Dr. Bartle's experiment. It was only necessary to devise a method by which material could be removed without contamination from outside sources.



Finding of inert germs in stratosphere by National Geographic Society expedition suggests, as illustrated by diagram, that epidemics are caused by down winds bringing bacteria to earth

After much experimentation he devised a technique so foolproof that he has continued to use it during hundreds of other experiments. First step in securing a specimen is to flame the surface with a blowtorch until it glows ruby red. Next it is

sprayed with a fifty-per-cent solution of phenol, a powerful disinfectant. Then a hole is bored three or four inches into the material. The hole is also flamed and sprayed with disinfectant. Then a small coring auger is inserted into the hole, care being taken that it does not touch the sides. With the coring auger specimens are taken from various depths. These specimens are placed in sterile test tubes by means of a sterile glass rod. All tools are sterilized before use, and carried in sterile towels. Should they touch anything that has not been sterilized, they are flamed with the blowtorch.

The cores of material taken from the old mission wall were placed in test tubes that contained sterile bacterial media, which

Test tubes filled with germ-laden material were frozen a year in ice then thawed and germs revived

supplied food and moisture for any organisms that might have survived since the year before the American Revolution—the date when the mission wall had been built. The next day Dr. Bartle looked at the test tubes. Nothing had changed. The following day there was still no change. On the fourth day, a slight milkiness, a touch of turbulence, showed in one of the tubes.

Half wild with excitement, Dr. Bartle placed some of the culture beneath his microscope. Before his eye swam millions of moving — living — organisms; organisms which had survived without moisture, air, or food for almost 200 years.

His hand still wasn't steady when he wrote on the chart:

"Ninety-six hours—thirty-seven colonies of living bacteria."

From then on Dr. Bartle was determined to establish whether there was any limit to the time which bacteria might remain dormant. He traveled thousands of miles searching for ancient structures which complied with the rigid conditions he laid down. Twice he crossed half a continent, only to find that the structure from which he hoped to take specimens had not been sufficiently protected from contamination.

But year after year he continued to secure older and older specimens, and in every case bacteria grew and flourished in his test tubes. Professor Charles Lipman of the University of California became interested, verified many of his results.

And then, deep in the age-old Teotihuacan Pyramid of the Sun, in Mexico, he found exactly what he had sought. Here was a structure whose age was not measured in centuries, but in millenniums. His blowtorch roared as he flamed a wall built 5,000 years before. And from this material, sealed away before the time of King Tut, he revived hundreds of colonies of bacteria.

Next Dr. Bartle heard that a National Geographic Society expedition had taken living organisms from the stratosphere, under conditions as nearly contamination-proof as humanly possible. These organisms, bacteria and spores, appeared to have been floating in the rarefied air where the temperature was seventy degrees below zero—and they had revived when placed under favorable conditions.

To further check the theory that bacteria could remain dormant in extreme cold, Dr. Bartle froze several test tubes full of organisms, kept them frozen for an entire year, then thawed them out. They promptly came back to life.

From these facts has come a new theory concerning the sudden appearance of epidemics of disease. If germs can be carried high into the stratosphere, they might remain for centuries at that high altitude, kept dormant by the low temperature. Then a strong down wind might carry them back to the lower atmosphere, where moisture and higher temperatures would cause them to spread a sudden epidemic.

It's still only a theory. But it explains a lot of hitherto baffling facts. And since Dr. Bartle has proved that bacteria are potentially deathless, the idea isn't so absurd.

Big Game Hunting with a MICROSCOPE

YOUR glass reveals queer creatures that live in a drop of water taken from a stagnant pond—Dense forests appear in the green mold of stale bread and fungi wave their strange lace-like tendrils

By BORDEN HALL

POPULAR SCIENCE MONTHLY JANUARY, 1933

DISSECTING MICROSCOPE
A fairly powerful pocket lens is mounted as shown at the left above a mirror that is set at exactly forty-five degrees. The glass table top is held in place with tiny brads and it is on this table that specimens are dissected

ODD WATER CREATURES
With a microscope, you can see in a drop of stagnant water, the water fleas, left, and the cyclops above. Note several female cyclopes with egg bags. Male is near edge of circle

FITTED out with the baggage I described last month, we are ready for our first journey into that strange world revealed by a microscope of reasonably high power.

Our first sight-seeing tour leads us through a growth of fungus—a weird forest that we will cultivate on a slice of whole wheat bread.

To grow this forest we simply place a piece of the bread in a damp spot in the cellar for a day or so. We shall soon find on its surface a delicate greenish gray growth, one of the common molds, nature's most delicate vegetation. By the careful use of our little scapel and needles mounted with handles (P.S.M., Dec. '32, p. 52), we separate a tiny speck of this material and place it on the surface of a glass slide. This we must do with patient fingers for we cannot afford to crush the delicate plants. Then, too, we must see to it that the specimen we take is so thin light will pass through it. A piece a little larger than a pin head will be plenty.

After it is placed on the stage of the microscope, we adjust the light until we secure an even field of illumination, not so bright that it will cause eye strain and not so dull that it will rob one of the view. Following the directions given last month, we then adjust the objective until it is about three-eighths to a half inch above the specimen and focus UPWARD. Presto! we enter the land of mold.

Mold is a common, unscientific name for fungi and what we gaze at really is a microscopic form of mushrooms or toadstools. These tiny plants present themselves like great bushes of fine fuzz. We may find many other interesting examples of fungi on old cheese, plants, and the bark of trees.

On our next excursion, we come to the first great adventure for every embryo microscopist: the examination of the life from a stagnant pool of water. If we obtain the right kind of water, the fleeting life that will sweep past our vision will make the traffic of a metropolis seem dull, indeed.

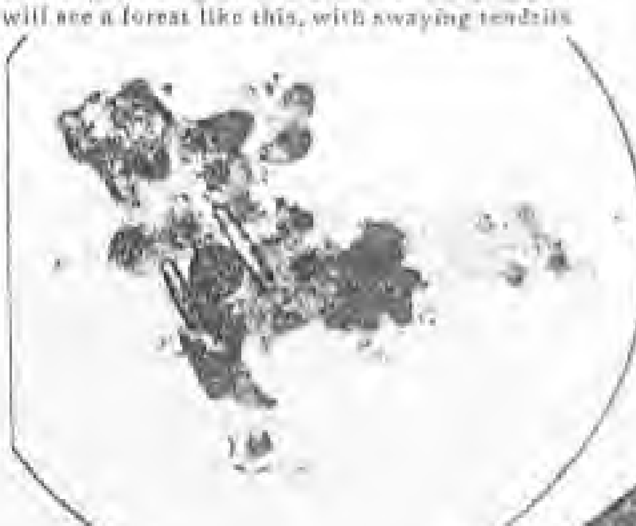
The professionals use special apparatus to collect aquatic life, but we can afford no such luxuries. So we take a wide-mouthed bottle or jar and attach to it a heavy piece of cord. A pint mayonnaise jar will be suitable. Stagnant pools of water can always be found near the city. The bottle is dropped to the bottom of the pool and dragged across the soft, muddy bottom. The experimenter should be sure to gather in some of the bottom mud for in it we shall find the most interesting animals.

Naturally, in the examination of this welter of life, both vegetable and animal, we shall have to take things as they come for we are dealing with the tiny life of the sub-world. It will not be long, however, before we come upon those lively creatures, the water fleas, both male and female, although the latter will greatly outnumber the former. We proceed by taking a small sample of water from the jar with a medicine dropper and placing a drop or two upon a glass slide. This is brought to focus under the objective.

Photomicrograph from New York Biological Supply Co.

THIS IS THE FOREST PRIMEVAL

Looking at the green mold on stale bread, you will see a forest like this, with swaying tendrils



FIRST LIFE FORM. Your glass will show amœbas, the simplest of all animal forms

leaving the tube of the microscope in a vertical position so the water will not run off and carry the specimens away.

The water flea is recognized by its jerky method of swimming. It uses anything but the Australian crawl. We shall not need a powerful objective for this crustacean for, full grown, it is one-sixteenth of an inch long. Indeed, nature has provided it with some pretty decent equipment.

If we watch closely we shall find that it has a head, a compound eye, feathery antennae, mandibles, and a tail. If our light is good, we shall be able to see the whole interior of the little flea. The beating heart will be visible as well as the digestive organs. If we are watchful, we will find a female with undeveloped eggs in the back of her body.

Sooner or later, we shall come upon a creature named for the mythical giant, Cyclops. Here is another crustacean that ambles jerkily through the watery lanes. He is a formidable appearing creature, with a single eye in the center of his flat head, a pear-shaped body, and a spike-like tail. Like the flea, he is provided with antennae; but he has five pairs of legs. The females may be distinguished by the bags of eggs they carry on either side of their bodies.

In our exploration of these lively scenes, eventually we come upon a little creature that is a sort of primer of life, a simplified edition of all living things. This is the amœba. It abounds in the mud and decaying vegetable matter at the bottom of pools and ponds. It measures about one-ninetieth of an inch but unfortunately we cannot describe an amœba exactly. The best we can do is to say that it is a tiny mass of protoplasm of no definite shape but capable of assuming many different forms.

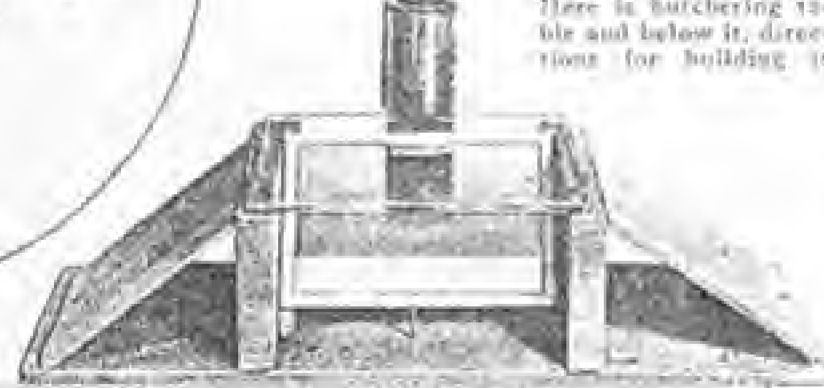
The amœba has no organs. With its slimy little body, it can make projections that serve as hands or feet. When it is hungry, it wraps its whole body about its victim and absorbs it. It digests without a stomach, walks without hands or feet, and without a trace of a nervous system, it responds to stimuli. We shall indeed be fortunate if we can observe the birth of an amœba, the simple trick of a creature tearing itself in half to make two.

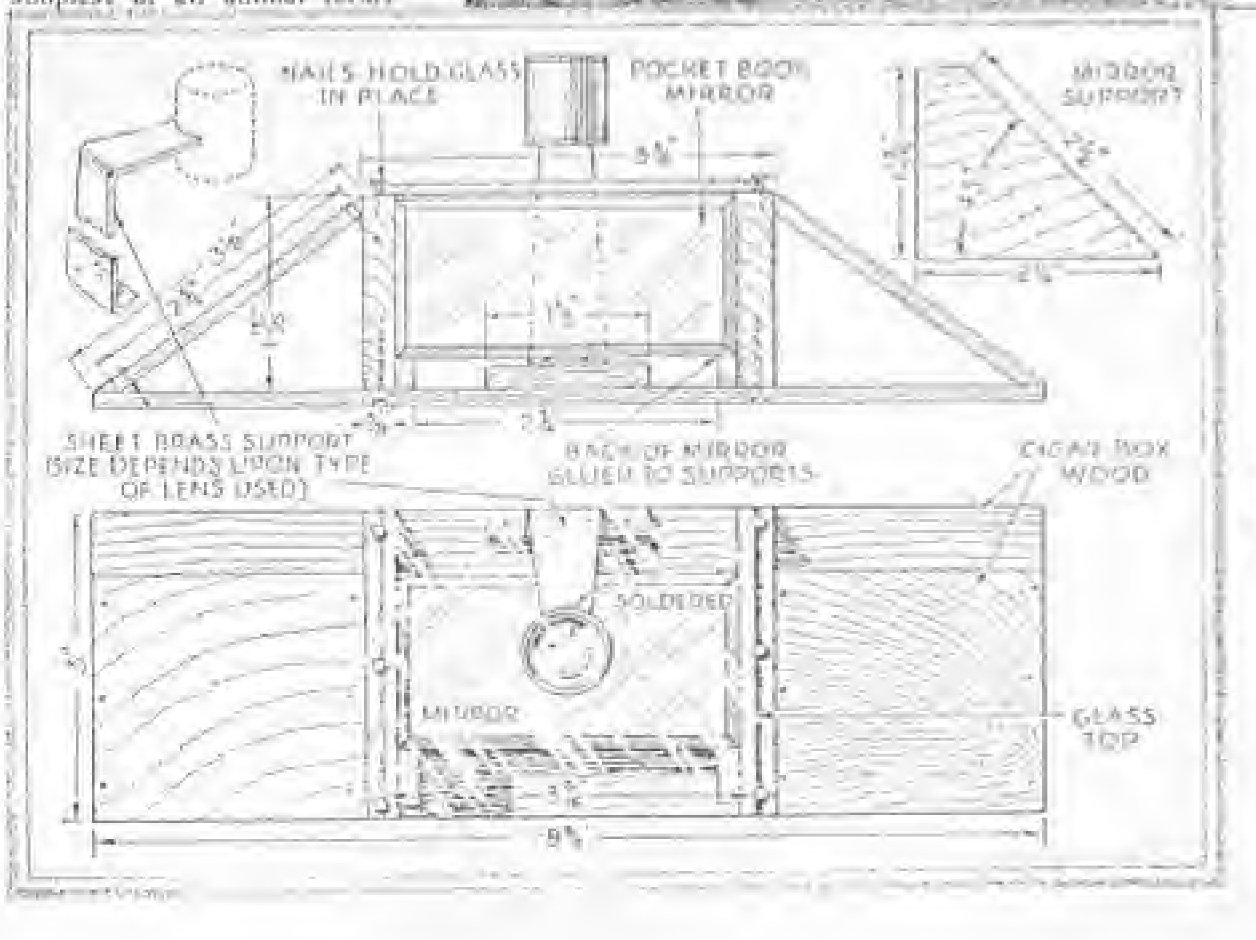
Interesting as the amœba is, we shall have to leave it to seek other wonders. For speed and prowess, we take our hats off to the polyzoons, the playboys of pond life. These tiny things, of which there are a number of varieties, live in colonies and are usually attached to the roots of aquatic plants. The polyps have strong family ties for they are found bound together with a sort of mucilage that assumes a shape like the mouth of a wine glass while in the water.

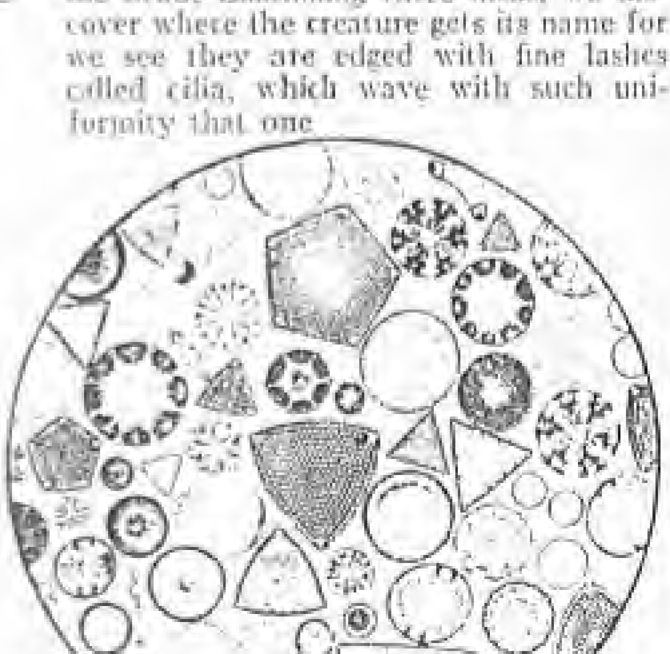
The little imps in this strange habitation are exceedingly beautiful and when actively feeding, we see them extending their delicate tentacles into the surrounding area with a lacy, wave-like motion. In so performing, they create a tiny vortex that draws their food into their mouths.

Then there are the rotifers, or "wheel-bearers." We may find them swimming carelessly about or in their idle moments, attached to some sort of marine vegetation. We note the sucker-like foot, the transparent body, and the two disks at the head. Examining these disks, we discover where the creature gets its name for we see they are edged with fine lashes called cilia, which wave with such uniformity that one

Here is hatchering table and below it, directions for building it







WHERE ARTISTS GET IDEAS

Diatoms are tiny plants that are found, as picture shows, in many different designs

might think they were revolving. Hence the name, wheel bearers. There is a purpose to this motion; by means of it the little creature brings food to its mouth. The polyzoons travel by looping their bodies like caterpillars.

We cannot afford to miss the diatoms—tiny bits of vegetation usually found in the greenish scum in the bottoms of pools. So many forms do diatoms take that men have spent their lives peering at them through microscopes and trying to classify them.

THE diatom is circular and is really a one celled plant enclosed in a flinty, hard shell. It is constructed on the principle of the pill box, a slimy secretion covering the exterior of the cell wall and permitting the plant to slide quietly and serenely along. We shall also find fossil forms of this life, the live ones being colored green with nature's most abundant paint, chlorophyll.

As we examine the little bit of water brought up out of the pool, we shall see many, many things that have not been mentioned in this article. We must recall that the population of the sub-world is almost as cosmopolitan as it is great. After all this is an excursion, not an expedition. If the curiosity of the serious student is whetted, he is referred to his local library where he will find many books on microscopy and the life of the invisible world.

As time goes on, we shall want to extend our operations and sooner or later we shall have to have a sort of butchering table upon which to remove the various parts and viscera of beetles, flies, and spiders.

For this work we shall have to make what is known as a dissecting microscope. The first thing that we shall need is a fairly powerful pocket lens. No definite specifications either in magnifying power or physical form will be given but I would advise getting the best you can afford. A small mirror, such as women carry, will also be needed.

The builder need only follow out the directions contained in the simple drawing on Page 47. There is nothing critical about this machine save the mounting of the mirror and care should be taken to see that this is at exactly forty-five degrees.

THE little standard in which the pocket lens is held will vary. The matter of mounting the lens will have to be left to the ingenuity of the reader. Of course, it should be mounted in perfect focus unless adjustment is provided for.

Cigar box wood is used along with tiny brads and a good grade of glue. The slanting members at each end of the machine are hand rests and it will be found well to include them.

In shaping the metal standards for mounting the magnifying glass, the builder should take care not to use too thin a piece of brass. If too thin, the lens will vibrate and interfere with vision.

The glass for the table top is held in place with tiny brads. Great care is needed in driving these in place for fear of breaking the top. If the builder wishes, he may use a good form of cement and so avoid the risk incident to the use of brads.

Just one more caution: we must not forget to measure the focal distance of the magnifying glass before we mount it in position.

Roadside Marine Gardens EXPLORED WITH YOUR MICROSCOPE

Scum from Stagnant Pools Yields Dainty Threadlike Plants That Are Fun To Study with the Magic Lens

By MORTON C. WALLING

POPULAR SCIENCE MONTHLY SEPTEMBER, 1938

A stick with a nail at the end for gathering specimens of algæ from ponds

NEXT time you are out for a walk or a drive, take along a few small bottles or jars with tight-fitting caps, and collect some of the green scum that floats in the water of ponds, lakes, and stagnant pools, and that clings to the rocks of almost any stream. You can easily transfer small masses of the scum to your jars with the aid of a stick a yard or so long.

You may think this scum an unsightly mess, but under your microscope it will reveal itself to be marvelously beautiful. Besides, you can learn, among other things, how nature anticipated a modern invention by some millions of years.

Pond scum is made up of countless slender filaments or threads of algæ, among the simplest of plants. These threads, some of which are branched while others are simple strands, are very much like vegetable beads. They consist of rows of cylindrical cells strung together end to end. Although connected, these cells really are rugged individualists, for when separated from the chain, they continue to grow and reproduce just the same.

Threadlike algæ are among the easiest objects to study with the microscope. All you need do is to place a few strands on a clean slide in a drop or two of water and add a cover glass. So abundant is the supply of material that you seldom need to make permanent mounts. Algæ can be found even in winter, in ponds and streams. The filament kinds, although more difficult than others to cultivate, can be kept for some time in an aquarium or in laboratory jars. Simply place some pond water containing the algæ into a jar, and add an inch or so of solid material from the pond bottom.

Today you hear much about transparent cellulose film being used to wrap things of many kinds—chewing gum, cigarettes, Christmas packages, bathing beauties, and pianos. This cellulose wrapping material has been available to human beings for only a relatively few years, yet nature, the champion of inventors, used it ages ago, and still employs it in great quantities.

The cells of the algæ threads are proof of this. Each is wrapped in a film of transparent cellulose. This material forms much of the outer membrane of the cell, and probably has a lot to do with protecting the contents against outside conditions. In some of the threads, you will see empty cells, in which the cellulose capsule is clearly visible. These cells probably were emptied by some water creature that lives on the plants. In fact, you can observe such tiny ani-

mals apparently feeding on the cell contents.

The cell walls of such plants as Spirogyra, one of the most beautiful forms, are not simple films of cellulose. There are, in addition, layers of cuticle and mucilage outside the cellulose, and a lining of cytoplasm, or outer cell material inside. But you probably will not be able to see these different layers with your microscope.

The protoplasm inside the cell contains such things as the cell nucleus, usually in the center; vacuoles, or liquid-filled cavities; and chromatophores. The chromatophores, or color-bearing bodies, are often the distinguishing features of an alga plant. For instance, Spirogyra gets its name from the green spiral bands encircling the cells on the inside, and forming a beautiful pattern. In other kinds of threadlike plants, the chromatophores are arranged like stars, strings of beads, plates, and disks.

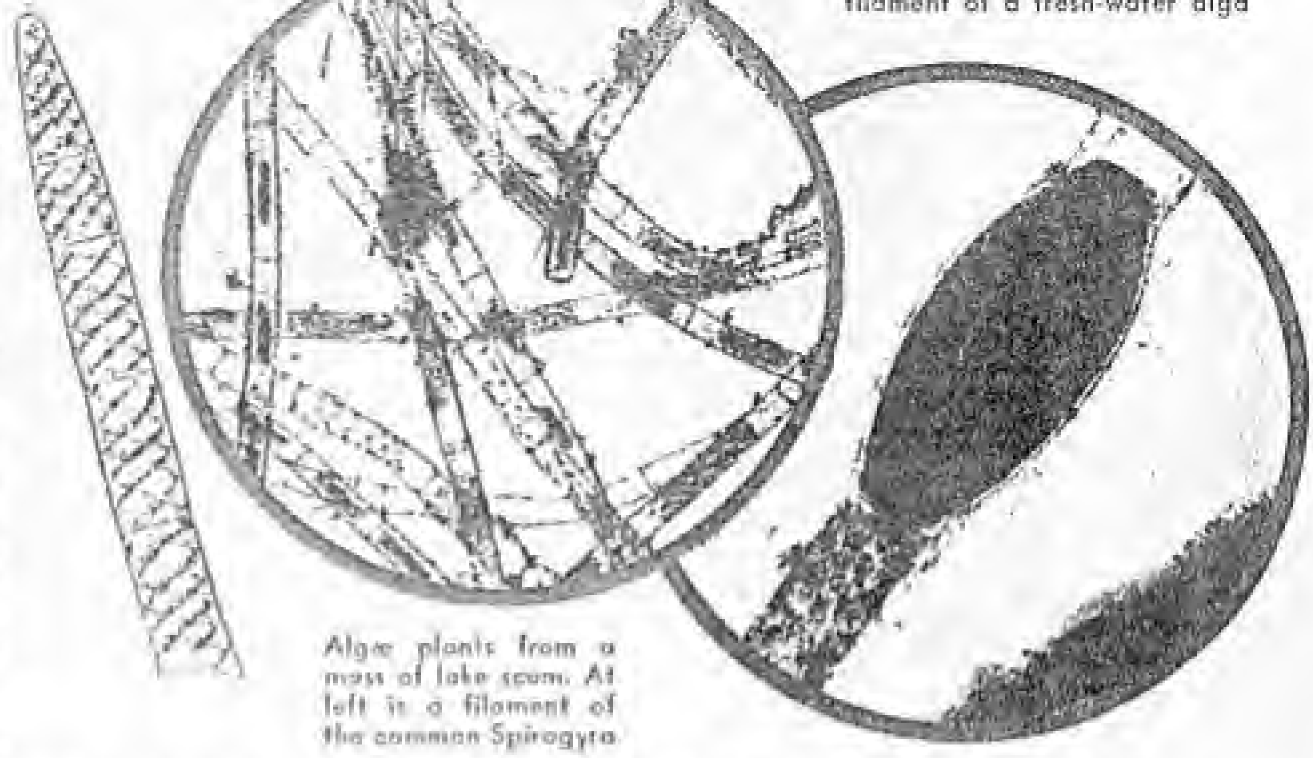
In some of these simple plants there are, within the green-colored material, small bodies called pyrenoids. Research has shown that these bodies are surrounded by starch, and that they contain albumen. Their purpose is not known definitely, but it is thought that they form reserve stores of food.

There are so many kinds of algæ—some 10,000 species are known—that it would be impossible even to name them all here. The filament types are numerous and abundant. Spirogyra is one of the best known and easiest to find. The average Spirogyra filament is about the diameter of a human hair, and each cell is about four times as long. The entire filament averages about five centimeters (nearly two inches) in length.

Other hairlike algæ that you may encounter include Genicularia, which has spiral chromatophores resembling those in Spirogyra but is considerably smaller; Zygnema, characterized by two star-shaped chromatophores in each cell, and usually found near the surface of water; Œdogonium, which often has a membrane marked with sharp ridges and grooves running across one end of cell; and Pithophora, which forms resting spores that are bulb-shaped, dense, and considerably larger in diameter than regular cells.

Pond scum is green because of the presence of chlorophyll in the filament-type algæ of which it is composed. However, there are many algal forms which are brown, red, yellow, or purplish-green in color. It is these plants, incidentally, which give color to the rocklike deposits around some of the hot springs in Yellowstone National Park. The plants live in the waters of the springs, al-

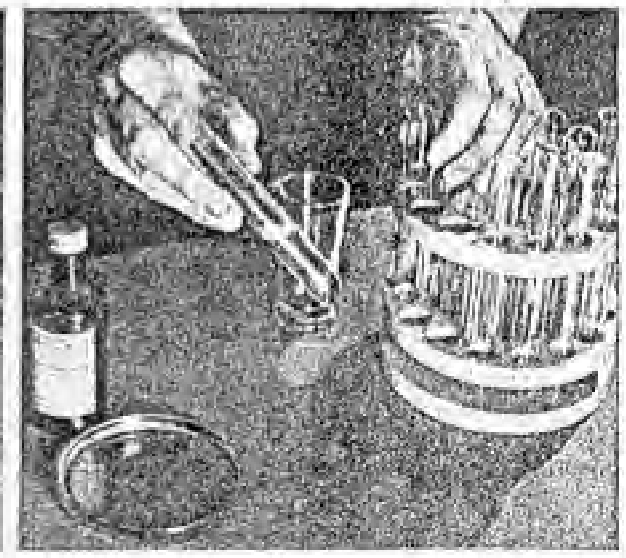
Below is a resting spore in the filament of a fresh-water alga



Algæ plants from a mass of lake scum. At left is a filament of the common Spirogyra

PREPARING ALGÆ SPECIMENS FOR EXAMINATION

At the right, specimens taken from a jar are being placed in a shallow dish for rough examination, as at left to determine whether the desired forms are present. Below, selected strands have been placed on a slide and are being stained with iodine. Lower right, shaking blue-green algæ in chloroform and water to reveal presence of chlorophyll



though they may be within forty degrees of the boiling point.

THE algæ that are red, brown, or some other color are really green at heart. If you find some of these filaments, you can perform an interesting experiment that reveals the presence of green chlorophyll. Put some water in a test tube or small bottle and add several drops of chloroform. Shake the bottle vigorously, and then let the chloroform settle. Pour off the water, which now contains a little chloroform, and put the colored algæ into it. The chloroform will extract the phycocyanin which modified the basic color of the cells, and leave the bright-green chlorophyll. You can extract the green chlorophyll by soaking the algæ in alcohol.

The chlorophyll has an important job to perform. It takes part, in some mysterious way, in the process by which the plant transforms carbon dioxide, water, and sunlight into starch that it can use for food.

By making repeated observations on algæ over a period of days or weeks, you can learn more about their habits than by single inspections. Spirogyra, for example, may be discovered only in the form of simple filaments, on your first exploration. However, one of the most interesting stages of its life occurs during conjugation, when two parallel filaments are connected by canals, producing a ladderlike formation. This is the usual method by which Spirogyra reproduces. The two filaments, one male and the other female, become joined together, and send out hairlike projections called papillæ, which unite to form canals joining adjacent cells. The contents of the male cell pass through the canal into the female cell to form a zygote, or spore, which later develops into a new plant. The emptied male-filament cells eventually rot away.

IN YOUR study of Spirogyra and other algæ, you will find it interesting to apply iodine or some other stain to bring out cell details. Iodine, for instance, will make the nucleus more prominent, and when applied in a solution strong enough to darken the entire cell contents, makes the cellulose capsule easier to see.

The filamentous algæ comprise only a small percentage of all algal forms known. The group includes the diatoms and a multitude of others of almost every conceivable form.

POPULAR SCIENCE MONTHLY JULY, 1933

Hunting Water Life FOR YOUR Microscope

By Borden Hall

MAKING A NET TO SNARE ANIMALS AND PLANTS FROM PONDS OR SEA WATER—HOW TO STUDY THEM IN TINY WATER CELL

A small hand lens is used to examine bits of underwater vegetation in search of specimens to be viewed later in the microscope

ONE is never even dimly conscious of the teeming life in the world that is crushed under one's feet or that swims and swirls through the depths of a pond until one views it through the lens of a microscope capable of multiplying images 300 times or less.

The beginner with the microscope is so appalled at the multitude and variety of living and non-living things that may be brought to the stage of his instrument that often he is unable to decide where to begin his investigation. During the winter time we have the crystals of salt, bread, mold, lice from plants, leaves, coal, hair, paper, bits of vegetables, and a host of other common household objects that offer unending sources of pleasure and instruction.

In the summer, nature offers a new world to explore. In former articles mention was made of the multitudinous forms of life to be found in pools of stagnant water. The subject was barely touched upon, however, and now we shall tell how specimens may be gathered from them and describe the new equipment we will need.

First, the amateur microscopist must learn how to pick out the jungles and the open veldt in which to do his hunting. An ordinary mud puddle that has been standing in the warm sun for several days is a likely hunting ground, especially if it lies in a wind-swept spot to which pollen and other life-bearing particles have been borne. The running brook or the lazy river or creek also will yield specimens well worth study. But the best place of all is a stagnant pool, where you can find a larger number of curious specimens of animal and vegetable life than in any other spot accessible to those living inland.

A FEW months ago, I suggested that we hunt microscope specimens with an ordinary, wide-mouthed bottle tied to the end of a string and dragged along the bottom of a pond. The surface of the bottom contains the most interesting specimens, especially in pools and ponds that are covered with green scum. Although the bottle makes a good hunting tool, a far more efficient instrument is the little net pictured on the opposite page. This is made of muslin with a small pill bottle attached to the bottom by a heavy rubber band. When this net is swept through the water and brought to the surface, the fabric will imprison the specimens and they will be washed into the little vial by the movement of the water.

Those who live near the seashore have available a theater of wonders that in many ways rivals the stagnant pool in the country. For instance, wondrous little specks of life called foraminifera will often be found in the ripples of sand left by the tide. These are small shells of single-celled animals and they assume a wide variety of forms. Many forms of life also are attached to rocks and weeds that grow in sea water. If we take a few bits of seaweed home, making sure to keep them in sea water on the way, we shall find they contain a number of interesting objects; tiny creatures, for example, that thrust forth little tentacles to entangle other minute forms of life.

NO CASUAL examination of this kind, however, is adequate, for if the scene is to be enjoyed in full, we must develop

a special method. The seaweed must be held in a trough or cell filled with sea water and viewed with a low-powered objective (the lens at the bottom of the microscope tube.) From the accompanying photograph, you can see how easily this useful little water cell may be made. It is not only valuable for peering at the strange life that fastens itself to seaweed but also for examining other specimens that live on the various forms of vegetation in rank ponds and pools.

Obviously it would be too much trouble to run down to the seashore every time

Before drying a specimen you wish to study, it is placed in a test tube and washed in alcohol, being cleaned by a brisk shaking

A flat specimen sometimes can be examined more easily if it is placed between two slip glasses that have been thoroughly washed

we wish to examine specimens or make new collections. To get around this problem, we establish a miniature sea right in our own homes. It can be done for a few pennies. We simply buy a small aquarium, provide it with sand, and fill it with sea water, being sure to add sea plants to bring about aeration of the water so that our specimens can live in it. In a short time, we can have a teeming community of many sorts of sea animals.

WHILE we are considering sea life, let us not forget the stunning varieties of colors and tints that are provided by fish scales of various kinds. The specimen chosen must be small and thin so that it will be translucent. These scales are easily mounted. Transparent parts of cray fish, crabs, and other crustaceans offer beautiful studies in animal structure.

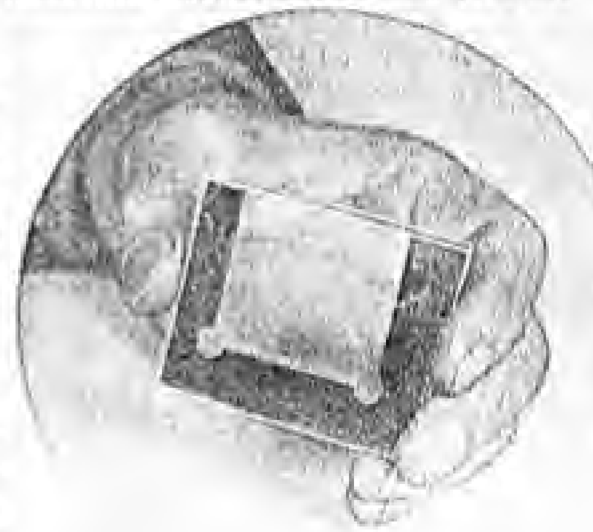
We must also provide a permanent home for our specimens of pond life. To

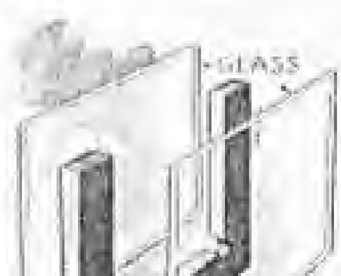
The inset drawing shows how a hunting net is made easily and cheaply. When fitted with a three-foot handle, it can be used, as the illustration suggests, in gathering pond life

do this we arrange a fresh-water aquarium into which plant life must go to supply the needed, life-giving oxygen. Unless the water has a certain amount of oxygen dissolved in it, our specimens soon will die. It is easy to place subaqueous plants in some mud in the bottom of the aquarium, pressing their roots in and then pouring the water over them.

Peering into pond water, we find those interesting, threadlike formations of vegetable matter called algae. To discover them, we use a microscope slide with a slight depression ground in it to hold water. When we find a specimen, we transfer it to a flat glass and use a more powerful objective. This transfer is made to facilitate examination with the more powerful glass. It has been noted previously that the higher the power of the objective used, the closer we get to the object. Algae are like beautiful strings of beads, the beads being vegetable cells such as those that go to make up the entire plant world. Here, however, nature, for some strange reason, has strung the cells out end to end.

Botanists classify this strange life as Zygnema and Spirogyra. The latter branch of the family is the more interesting. It is plentiful in slower streams, hanging from the stems of weeds in long streamers. In stagnant pools, it grows by itself in scummy masses. Each cell of this plant has its bright green spiral chloroplast, a form of chlorophyl which is the substance that gives plants their green color and their ability to make sugar from water and





WATER CELL FOR SEA LIFE

A water cell, made of two glass slides fastened together as shown in drawing at left, affords a convenient way to place living sea specimens under a microscope

carbon dioxide through a process called photosynthesis.

A SPECIMEN is stained with a weak solution of iodine. In an earlier article, I told how certain dyes are used to color specimens so that their less colorful portions will be more easily seen. When

this tiny plant is treated with iodine, you can see in each cell the nucleus, the nucleolus, and the protoplasm as yellow masses.

No thrill is greater to the microscopist than that of witnessing the mysterious process of creation. It is only through the microscope that this is possible. We can see it in connection with spirogyra. Here we may see two filaments coming together. The threads unite and the filaments lose their normal appearance. Watching closely, we note further that the chloroplast loses its normal form and the cell walls are absorbed. Finally the contents of the cells of one of the threads pass into the cells of the other. In a short time, the blended contents will produce spores from which new plants will develop.

ANOTHER amazing method of reproduction is revealed by the spinning globes of Volvox Globator. High power is not needed to discover them for they measure about one twentieth inch in diameter. To discover them, we use a water cell, dropping the microscope to a horizontal position and slipping the cell under the stage clips in the same manner as that used for an ordinary slide. Some of the water is transferred to a slip glass with a ground depression.

At first we may not succeed in capturing the wily globator but on the second or third attempt, we shall succeed. Here is a wonder of wonders—life that takes the form of balls within balls. Looking closely, we find that the outer ball has two lashes which function like the fins on fish in bringing about locomotion. If we are patient, we can see the outer, or mother ball, grow old, peel off, and slip away to its aquatic grave. This exposes the second layer which takes up the duties formerly discharged by the layer just removed. Animal or vegetable? This is still a moot question.

In water from the bottom of a stagnant pool, we find another interesting form of life called desmids. These are single-celled plants, so nearly transparent that we can see the protoplasmic transformations that are constantly going on within them. Here is a whole afternoon or evening of enjoyment in itself.

WE SEARCH decayed vegetable or animal matter for the eggs of the common house fly (Diptera or two-winged class of insects). Sooner or later we find them, transfer a few to a slip glass along with a bit of the decayed matter, and place them under the microscope equipped with a low-powered objective. No need for long waiting, for the house fly, as we all know, is a fast breeder. In two days the eggs have hatched and the larvae set about feeding on the decayed matter. Six days of this and they enter the pupa stage. The fully developed insect comes after some seven days in the chrysalis form and the amateur microscopist can follow this entire development.

Further study of the ordinary house fly may be carried on profitably. We capture a big fellow, give him an alcohol bath, and proceed to dismember him with our operating equipment. A wing is pulled off with the tweezers, placed on a slide, and examined. Nature is a masterful airplane designer as we shall note. A leg is clipped off at the body joint with the tiny shears or a razor blade. It is slipped between two glasses and placed on the stage. Now we see how flies so easily climb the wall and walk on the ceiling. Powerful claws form each foot in addition to bristles with which the fly grooms itself. We cut out an eye, place it on a glass and slip a high-powered objective (300 diameters) into place. We notice the eye is covered with dots resembling honeycomb construction. Each dot is an eye in itself —a thousand eyes in one.

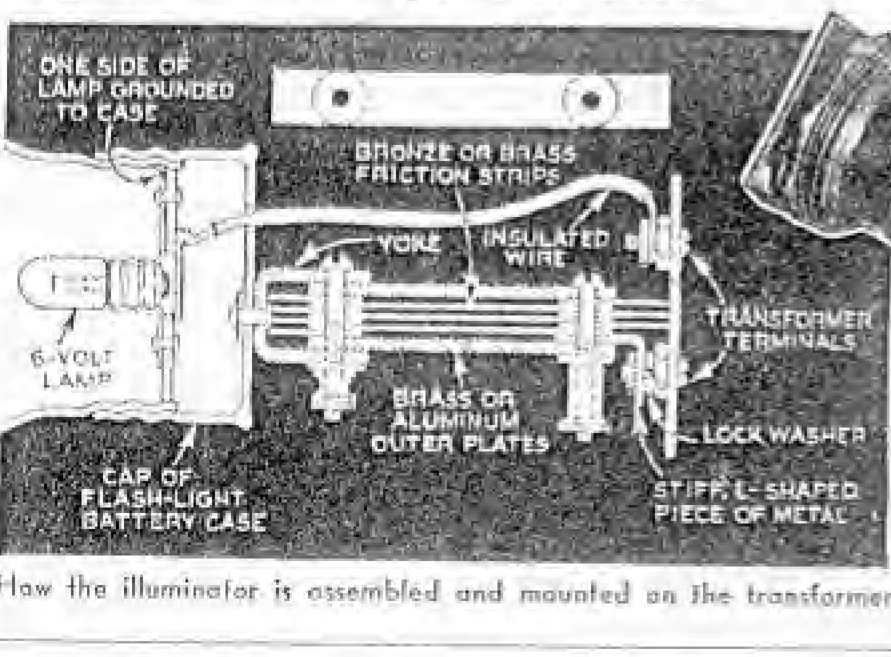
THE same process is carried out with the mosquito, starting with the larvae. A large colony of these pests may be started by merely placing a bucket of stale water, taken from a mud puddle, in a sunny spot in the back yard. If we replace the water as it evaporates, we shall notice in a short time, little objects moving about by flipping their tails. They are small but may be seen with the naked eye. Some of them are scooped into a glass and placed in a water cell. Only a lower-powered objective is necessary to study these insects. The mosquito is not an aqueous animal. It has to breathe and while it lives in the water it cannot take its oxygen supply from it. The periodic trips of the larvae to the surface are noticed. Each insect pokes its breathing apparatus through the water surface, sucks air, and drops back.

Now we can understand how the Government experts kill countless billions of these pests every year. The objective of the microscope is set on a line with the surface of the water in the water cell. By moving the cell, we may then sweep the whole line of the water surface. A single drop of heavy oil is placed on the surface of the water with a medicine dropper. It immediately spreads out into a thin, tough film. Up come the larvae to breathe. They push against the oil film. It is elastic and we see it give under the pressure but it does not break. Again and again the insect struggles to break through to the source of life-giving oxygen, but the film holds and the larvae at last sink to the bottom of the vessel dead.

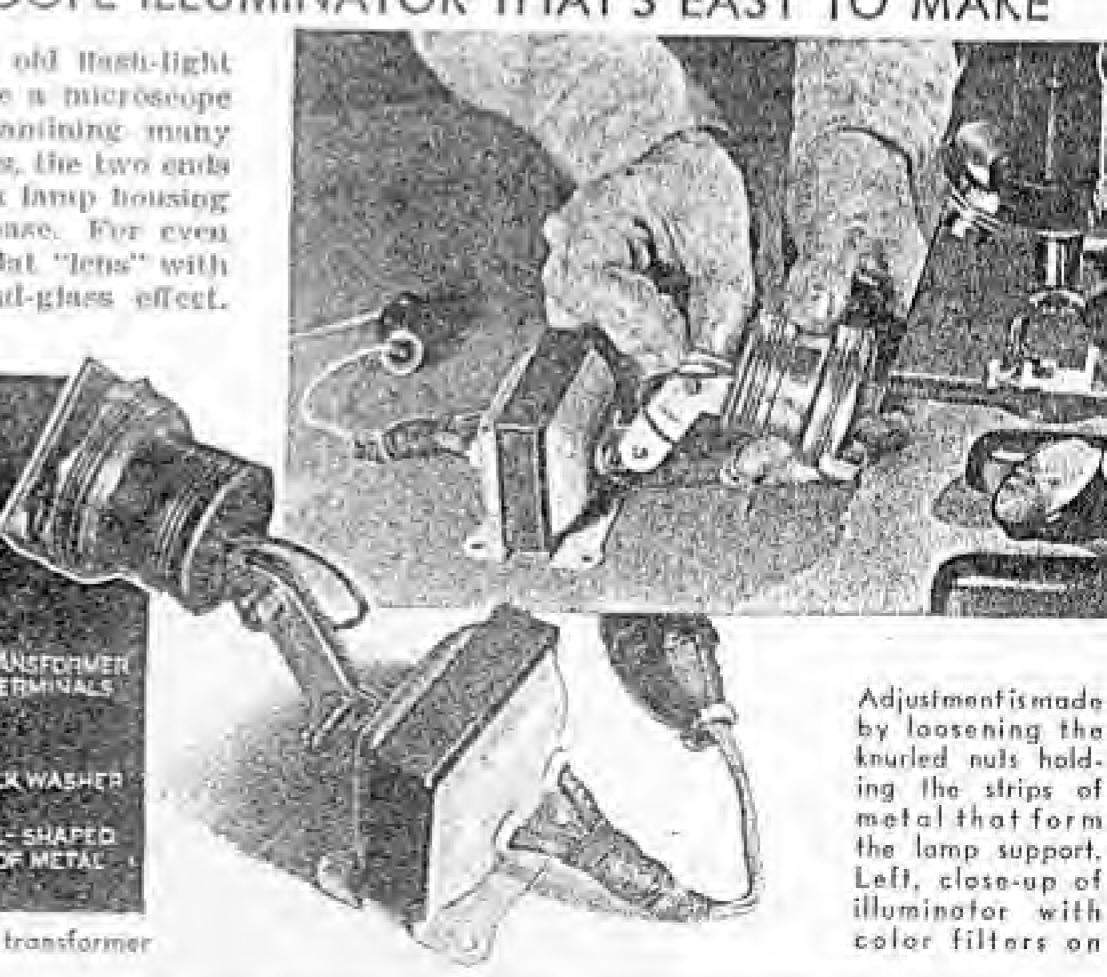
Everywhere there is work and fun for the amateur microscopist. The more serious students are strongly advised to read one or more elementary books on biology and botany.

HERE'S A HANDY MICROSCOPE ILLUMINATOR THAT'S EASY TO MAKE

FROM a six-volt doorbell transformer, an old flash-light case, and a radio-dial lamp, you can make a microscope illuminator that will prove useful in examining many kinds of subjects. As shown in the illustrations, the two ends of the flash-light case are combined to form a lamp housing which is mounted on the transformer as a base. For even diffusion of light, grind both surfaces of the flat "lens" with moistened abrasive powder to give a ground-glass effect. Clips soldered to the lamp hold color filters.



How the illuminator is assembled and mounted on the transformer


Adjustment is made by loosening the knurled nuts holding the strips of metal that form the lamp support. Left, close-up of illuminator with color filters on

POPULAR SCIENCE MONTHLY NOVEMBER, 1937

Hunting Little Big Game with Your MICROSCOPE

By MORTON C. WALLING

EXPLORING probably is the most fascinating of sports. And you can enjoy it as much as you want to—if you have a microscope. Invading new realms with your magic lenses can be just as fascinating as an expedition to the jungle or a visit to the ocean floor—and a whole lot cheaper and safer. For example, you will find the thrill of marine exploration in examining the strange creatures that inhabit the waters of stagnant puddles, garden pools, aquariums, and the like.

The microscopic animals grouped together under the general name of Protozoa provide endless entertainment for the microscopist because they are so plentiful both in form and in number. Furthermore, the Protozoa are of great importance to science because, being the simplest of living animals—consisting of but a single animated cell—they afford a means of studying fundamental life processes. For instance, a thorough study of the crawling amoeba will tell the scientist much about the amoebalike cells found in the human body, and about diseases traceable to alien amoebas that get into the human system.

There are several convenient sources of protozoans. Perhaps the simplest way of collecting a supply is to go on a little expedition, equipped with a dipping tube or bottle and a jar having a screw cap, for the purpose of collecting water from stagnant ponds, lily pools, and the like. There is hardly any open body of water that does not swarm with interesting microscopic life.

The dipping tube consists merely of a straight piece of glass tubing at least a foot long. If the ends of the tube have sharp edges, heat the glass in a gas or alcohol flame until the edges have become rounded. To use the tube, hold one end shut with your finger and plunge the other end into the water to the required depth. Then raise your finger for a moment to permit the trapped air to escape. The water will rise in the tube to its normal level. Replace your finger, and you can lift the tubeful of water and empty it into your collection jar. In such collecting, try to get a considerable quantity of solid material from the pond bottom. The slimy layer that usually covers the bottom is rich in living creatures.

A dipping bottle is a small glass bottle or vial fastened to the end of a stick so that it looks like a glass-headed croquet mallet. It is used like a dipper to scoop material from the bottom of streams or ponds.

When you have returned to your microscope desk, transfer, with a dipping tube or medicine dropper, a drop or two of the pond water to a clean microscope slide. Get some of the solid material, too. Lay a clean cover glass over the drops, and you are ready for the trek into unknown country. As for magnifications, fifty or 100 diameters is sufficient for general searching, because this gives a less restricted field and better illumination, to say nothing of the clearer definition in many microscopes. After you have located an interesting specimen, and perhaps persuaded it to remain still by one of the methods described below, you can switch to higher powers for closer study.

HUNTING PROTOZOANS

Living creatures are easily captured in stagnant ponds or lily pools with the simple dipping bottle pictured here. It is made by fastening a small vial to the end of a stick by means of rubber bands, as illustrated above, and is used like a dipper to scoop up samples from promising locations

Because of the great many different protozoans it is impossible to describe all of them here. However an attempt will be made to mention, at least, some of the more common and important varieties.

Biologists have divided the Protozoa into three groups, the amoeboid protozoans or Sarcodina, the flagellate protozoans or Mastigophora, and the ciliate protozoans or Infusoria.

The first group gets its name from the amoeba, simplest of one-celled animals. These creatures have one outstanding characteristic: they move about by extending the protoplasm that makes up the cell until it forms temporary feet, pseudopodia. The amoeba literally flows into its foot, as you will discover by watching one with your microscope. *Amoeba proteus* is the best-known member of the group. It is essentially a naked single cell, looking not unlike a drop of jelly that contains several solid particles.

When first placed on a slide, the amoeba usually gathers itself into a globular drop, but after a time you will see a branch grow out from the drop and perhaps another and another. These are the temporary feet. With them, the amoeba moves about, engulfing bits of food. The processes that go on inside an amoeba are rather complicated and can best be studied with the aid of a good textbook that describes them in detail.

Other members of the amoeba's family may take any of a variety of appearances. Some of them secrete a substance that hardens into a protective covering. Others gather together tiny grains of sand and cement them into a hollow shell. You will be astonished by the skill displayed by these simple creatures, for the grains look as if they had been fitted together by a master mason, and the shape is as uniform and exact as if an architect or engineer had supervised the work. Typical of these sand-grain masons is *Difflugia urceolata*. It builds an ingenious sand shell shaped like an old-fashioned balloon. The inside compartment of the shell is slightly larger than that required for the amoebalike inhabitant. Difflugia can produce pseudopodia at will, and extend them for the purpose of moving about or capturing food. There are numerous other forms taken by the shells of creatures like Difflugia. You will have no trouble finding such shells if they are present in your pond water, for they may be large enough to appear as a tiny speck to the unaided eye.

Arcella vulgaris is an example of a smooth-shelled relative of the amoeba. When seen from above, the shell looks like a doughnut; from the side, it somewhat resembles a football. The one-cell animal, which can put out pseudopodia like all its other near relatives, is attached to the shell by tiny strands. Sometimes Arcella has a shell marked with undulations.

In a drop of water, you will find creatures as strange as those of any jungle

Vorticella campanula anchored to a fixed object by its springlike stem. At the right is a group of protozoans, with streamline Euglena in greatest numbers

Flagellate protozoans have one characteristic feature that will enable you to recognize them. They move about by means of flagella, or slender threads extending, like a whip, usually from one end. By lashing these threads about, the creatures draw or push themselves through the water. When only a single flagellum is present, it usually is at the front end. By whipping it about, the animal draws itself along. Many of these organisms have several flagella, some trailing behind and some extending from the side.

A COMMON form of flagellate is *Euglena viridis*. It is a smooth, tapered, streamline creature with a slightly rounded forward end, from which the flagellum extends. The nucleus is in the center. Usually, Euglena is green because of the chlorophyll it contains, which is believed to be used by it for manufacturing food just as a plant does. Sometimes the green material is missing, and the animal then apparently gets along by capturing outside food. Near the flagellum end you may be able to make out a red spot. This is called the eye spot because it is believed to be sensitive to light.

Volvox globator appears as a perfectly formed sphere that rolls about in the water on the slide. This creature is really a colony of flagellates, numbering several hundred. The best time to capture Volvox is in the spring.

Ciliate protozoans differ from the flagellates by having, as a means of locomotion, a great many short hairs, or cilia, which they manipulate like the scores of oars of an old Roman galley, to propel themselves through the water or to fan the water past them and bring food particles within reach.

Paramecium caudatum is perhaps the best-known member of this group. It is called also the "slipper animalcule" because it is shaped somewhat like a low shoe. It is characterized by its shape, by being covered uniformly with cilia, and by a slitlike mark along one side. It swims about with a graceful, wavy motion.

WHILE the paramecium is free-swimming, another ciliate, *Vorticella campanula*, anchors itself to some fixed object by means of a slender thread that it can roll up like a corkscrew. In general, it looks somewhat like a bell-shaped lily blossom on a long stem. A ring of cilia around the outer end (ciliary disk) brings food to it. The nucleus looks like a curved band. When Vorticella is frightened, as by some object touching it, the stalk contracts suddenly like a released spring, jerking the animal out of the way. At the same time, Vorticella folds its cilia inward and contracts into a ball shape something like a strawberry.

Stentor polymorphus is an interesting ciliate that can either swim about or anchor itself to a stone or bit of vegetation. It is shaped like a long funnel. The upper end of the funnel bears a spiral row of strong cilia, which help in locomotion and food gathering. The body is covered with smaller cilia, and may have some spines also. This is one of the larger protozoans. It is found on roots and leaves of water plants.

Coleps hirtus looks somewhat like Difflugia because it has a hard shell that resembles a hand grenade. Its shell is of regular construction, consisting of rows of plates arranged in zones. Cilia project through openings between the plates. The mouth is encircled by a row of teeth intermixed with large cilia. Coleps occurs in ponds and in hay infusions that have stood a long time.

There are scores of other ciliated protozoans, any one of which you may find under your lens. Some look like paramecia, while others do not look like anything in particular. The best method of making identification, if you want to engage in serious study is to obtain a reliable reference book containing pictures and descriptions.

Spreading a layer of albumen fixative on a slide to trap a creature in a drop of water

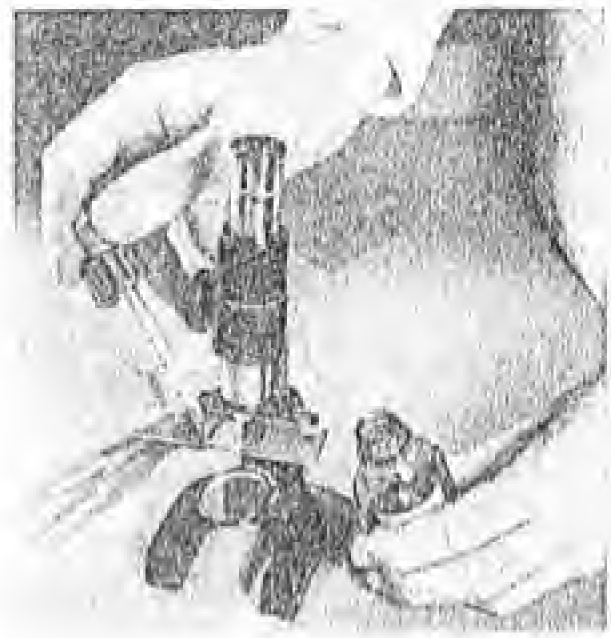
IN ADDITION to collecting water from ponds, streams, and even the ocean, you can obtain protozoans in a number of other ways. A common one is to make a hay infusion. Simply gather a handful of dry grass or hay, and put it to soak in a jar of water. Usually, water from a pond or stream is better than that from the city mains or a well. After a few days, you ought to have an abundance of microscopic life—along with considerable odor, which you can disregard.

Another way to obtain specimens is to gather half-decayed water-lily or other aquatic-plant leaves and put them in a jar of water for a few days.

Euglena can be produced in abundance by covering some crushed rice with pond water for two weeks. Paramecia can be raised in a culture made by boiling dry

A hay infusion, made by putting dried grass into a jar half full of water and letting it stand, will provide many interesting specimens

To slow up the movements of tiny animals, you can snare them with cotton, or put them to sleep with an anesthetic, as shown below



water lily leaves for a quarter of an hour, removing floating material, and next day adding water containing paramecia.

Keep infusions and jars of water containing pond life in the light, but not in direct sunlight.

You will find that many protozoans are too lively to be observed in detail. There are various ways of slowing them up. You can make them drunk by adding a drop of very dilute grain alcohol to the water on the slide. Chloretone can be used instead. A little albumen (white of egg) added to the water will slow the movements. Similar results can be obtained by dissolving gelatin (the kind used for desserts will do) in the water. A network formed of cotton fibers or the fibers of a piece of filter paper will restrict the area of movement of the tiny creatures.

YOU may have difficulty in seeing the delicate flagella or cilia of protozoans. Dark-field illumination will help, if you have the necessary equipment. Another method is to stain the cilia. Noland's staining-fixing solution for this purpose consists of two cubic centimeters of glycerin, forty cubic centimeters of a saturated solution of phenol (carbolic acid) in water, twenty cubic centimeters of formalin, and ten milligrams of gentian violet dye. In mixing, add a few drops of water to the dye, and then add the other materials. Place a drop of this reagent and a drop of the infusion to be studied together on a slide. If staining is too

Some Things You Should Know About Microscope Lenses

THE term "compound microscope" is used to distinguish a certain type of multilens magnifying instrument from simple microscopes such as Sherlock Holmes's reading glass. A compound microscope consists essentially of a tube having at its lower end an objective lens or system of lenses and at its upper end an eyepiece or ocular system.

The objective acts like a tiny, short focus simple lens—it may even be such a lens—and magnifies the object on the slide, forming an image near the upper end of the tube. The eyepiece, acting like another simple lens, is focused on the image formed by the objective and magnifies it still further.

Magnification of a microscope is commonly changed in one of three ways—by using a higher or lower-powered objective, by using an eyepiece of different magnifying power, or by increasing or decreasing the tube length.

In selecting a microscope, magnification should be a secondary consideration. Magnification alone is worthless; the lenses must give good resolution as well. In other words, the details of the magnified image must be clear. A cheap instrument may produce a magnification of 500 diameters, as the manufacturer claims; but the image will be so blurred because of poor resolution that nothing whatever is gained by the magnification.

Resolution depends primarily upon the materials and workmanship that go into the lenses. The use of high-grade optical glass, plus careful grinding to eliminate as many of the inherent lens faults as possible, is necessary. Such things cost money, which accounts for much of the seemingly high price of a good microscope.

Microscope lenses may or may not be marked to indicate their power and other characteristics. Present-day practice is to mark "professional-type" objectives to indicate their focal length, magnifying power, aperture, and sometimes the degree of color correction. Usually of greatest interest to the average amateur is the power, generally stamped in some such way as "10 X," meaning that the lens has a linear magnification of ten. Amateur microscopes seldom are marked for objective power.

Eyepieces, when marked, bear some such figure as 5 or 10, or maybe 5 X or 10 X, indicating the number of times they magnify the image formed by the objective. Special eyepieces, such as those intended for use with objectives highly corrected for color, bear further markings. Again, many amateur microscopes bear no markings on the oculars.

Total magnification of a compound microscope is determined accurately enough for all practical purposes by reading the scale on the draw tube, when one is provided, or by multiplying the magnification of the objective by that of the eyepiece.

deep, use less reagent in proportion to the water.

Making permanent slides of protozoans is a little more difficult than making slides of simpler specimens such as diatom skeletons, because the tiny creatures must be killed and fixed without distortion.

First it is necessary to trap the protozoans. This is done in the same way that you capture flies with flypaper. Make some albumen fixative as follows: Beat the white of an egg, let it stand a while and then skim the froth off the top. Filter the remaining liquid through cloth, or through paper with the aid of suction, and add an equal amount of glycerin. To prevent spoiling, introduce a little thymol or salicylate of soda, about a half gram for each twenty cubic centimeters.

SMEAR the slide with this fixative, and drop on the film a little water containing the specimens. Let the water evaporate until the fixative is only slightly moist. Then immerse the slide in the fixing agent, which will kill and "set" the protozoans. A suitable fixer consists of ten cubic centimeters of a saturated solution of corrosive sublimate in water and one cubic centimeter of glacial acetic acid. Fix for several minutes, then stain, dehydrate, and mount in balsam. (NOTE: solutions containing corrosive sublimate are very poisonous. Handle them with great care, and keep them out of the reach of children.)

You can, of course, vary the technique here and there. For instance, instead of dehydrating and mounting in balsam after staining, you can mount in glycerin. Simply put a few drops of dilute glycerin on the slide, and set aside in a dustless place until the water evaporates. Then add the cover glass, seal the edge with paraffin, and finally ring with lacquer.

Hunting STRANGE CREATURES with your Microscope

POPULAR SCIENCE MONTHLY SEPTEMBER, 1935

By MORTON C. WALLING

A hydra photographed under the microscope. The projection at the lower end is a bud, which later will detach itself to form a separate animalcule

Protozoans and other microscopic animals may be stained with neutral red, as at the right, by dropping the stain at one edge of the cover glass and making it flow underneath to a blotter held opposite

THE difference between the microscopist who attempts to "bring 'em back alive," and the hunter who stalks an Asiatic tiger with similar intentions, is mainly one of the size of the game. Capturing microscopic organisms and making them behave can be every bit as exciting as the subduing of larger animals—and it is much safer.

There are good reasons why almost every amateur turns to a drop of stagnant water for his first thrills in microscopy—and returns to it time and again as long as he pursues his hobby. In such a drop is a world teeming with life, a world peopled by a seemingly endless variety of strange little creatures which are always ready to put on a show. These interesting performers usually are not difficult to find, for they abound in back-yard lily ponds, roadside ditches, fish aquariums, and wherever else there is water that stands undisturbed for considerable lengths of time.

The creatures to be found in such places have been described in earlier articles of this series. Doubtless, every microscopist who has been engaged in his hobby more than a few hours, already has made the acquaintance of many of them. He has discovered that it is not always an easy matter to make them behave while he studies them. In fact, even to find a particular specimen may be surprisingly difficult; and when, at last, it is captured, it may add insult to injury by galloping all over the slide, making it next to impossible to see details of its anatomy. A few ways of making protozoans and other microscopic creatures behave will be described.

For capturing specimens in lily pools and stagnant ditches, you need nothing more than a piece of glass tubing a foot long and a few one- or two-ounce bottles with tightly fitting corks. The collecting bottles are to be filled about three fourths full of water and the rest of the way with the sediment that forms a layer over the surface of the pond bottom. Hold a finger over one end of the tube, and lower it into the water until the other end touches the sediment layer. Lift the finger, and the

water will rush into the tube, carrying some of the sediment with it. Replace the finger, lift the tube out, and transfer its burden of water and sediment to a bottle. Use the same method to transfer specimens from bottle to slide.

Add a quantity of dry hay to a jar of water and let it stand for two or three days in a well-lighted place, but not in direct sunlight. At the end of that time, it will contain a surprising number of microscopic specimens. Water that has been standing in a container for a day or two is better than water taken directly from a faucet, because it is free from excess dissolved oxygen and other gases. Lettuce leaves also can be used to make an infusion that will provide other types of little animals.

An aquarium, especially one that contains both fish and growing plants, in which the water is not changed often, will yield a normally invisible menagerie that will keep you busy for hours. The waste matter that collects on the bottom, frequently is alive with rotifers, little creatures whose activity and complexity of structure makes them interesting microscopic subjects. With the rotifers may be found little wormlike animals or nematodes, close relatives of vinegar eels. Hydras, many-armed animals just barely visible to the naked eye, sometimes can be captured on the walls of an aquarium nearest the light.

The usual way of preparing these organisms for observation is to transfer them to a clean glass slide in a drop of the same water in which they are growing, and then lower a clean cover glass over the drop to flatten it out in a thin layer. If you are not careful, the water will evaporate before you know it, and your zoo will shut up shop in a hurry. It takes scarcely a half hour for all the water to disappear from beneath a cover glass under average conditions, though the only surface in contact with the air is a thin line around the edges of the cover!

Every fifteen minutes or so, add water to that on the slide. Simply place, with the aid of a medicine dropper or pipette, a little water on the slide at one edge of the cover glass, where it will touch the edge but will not flow over the top. The water will be drawn between slide and glass by capillary attraction.

If you must leave the preparation for longer than a quarter hour, there is a way of preventing loss of your specimens. Simply apply a ribbon of petroleum jelly along the slide edges, so that it forms a seal that prevents the air from reaching the water. Some kind of "grease gun" will have to be used for this. Perhaps you can obtain an empty collapsible tube of the type commonly used for applying salve to the eyes. Such tubes have long, slender nozzles. Fill the tube by removing the clip at the end, and, if necessary, flatten the nozzle slightly to make the ribbon thin and wide enough. Another way of making a petroleum-jelly gun is to fit a fine-tipped medicine-dropper tube with a little plunger that can be pushed forward to expel the jelly. In filling such a gun, do not include any more air than is necessary.

To study a lively paramecium, rotifer, or microscopic worm while it is cruising about beneath the cover glass, is a matter of juggling more than anything else. It is a never-ending marvel that there is enough space beneath the cover glass, in a single drop of water, for so much activity to take place. But, of course, you are magnifying everything perhaps 500 times, including the cruising space of the creatures.

MANY times it is desirable to slow down the activities of the specimens. There are several ways of doing this. You can let the water evaporate until the cover glass, drawn towards the slide by the surface tension of the water, presses the specimens so tightly that they cannot move with their usual agility, yet not forcibly enough to crush them. The disadvantage of this stunt is that the time interval during which observations can be made before the creatures are smashed completely, or die from lack of water or oxygen, is not very great. There also is some distortion as a result of the pressure.

Some microscopists mix gelatin with the water, to produce a thick liquid in which the animals find it difficult to navigate with their customary speed. You can obtain gelatin at any drug store, in sheet or granular form; the unflavored kitchen variety, intended for making deserts, also is suitable.

Perhaps the easiest way of confining the activities of the specimens to small areas and slowing them down to a speed that permits detailed study, is to place a bit of ordinary absorbent cotton beneath the cover glass before adding the drop of water. Spread the cotton fibers out into a thin layer, so that they form a network. The creatures will be trapped within the meshes of this network, and thus kept within bounds.

Although a great deal of their structure can be observed by studying protozoans and other minute organisms in their natural condition, the application of stains will bring out otherwise invisible characteristics. But the majority of microscopic stains quickly kill these delicate creatures, often causing them to fold up into meaningless balls. There is, however, an

How to Make Permanent Slides

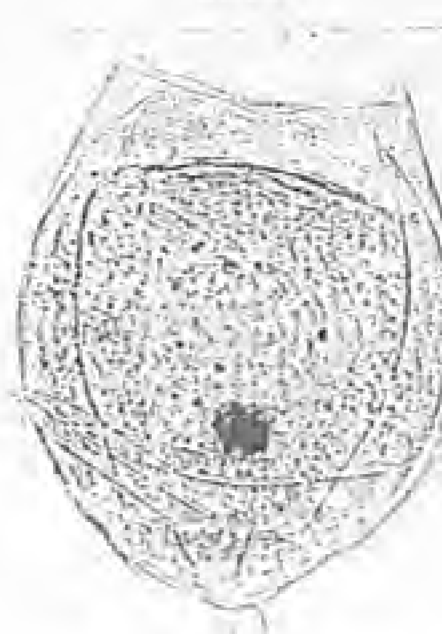
1 The first step in making a permanent slide for animal specimens is to apply a coat of albumen fixative to a slide

2 With a dipping tube, a drop of pond water is transferred to the slide. The use of the dipping tube, explained in this article, aids in collecting specimens and proves handy in many other operations

3 The protozoans trapped on the albumen-coated slide are fixed by immersing it in Worcester's fluid, the formula for which is given elsewhere

Although it looks like a plant, the strange specimen pictured above is an obelia, a colonial organism that lives in the sea. It was stained to show its structure

Silica diatom skeletons, like the pair shown above, often are found in pond water in which microscopic animals are being trapped. These plant forms have great beauty. At the right is a living diatom which was caught on an albumen-coated slide during the preparation of specimens of protozoans and the allied organisms with which they live



What Is It?

HERE is a chance to try your eye at a little microscope detective work. The specimen shown in the photomicrograph was found in a drop of sediment from a back-yard lily pool. Do you recognize anything familiar about its general appearance? Does it remind you of any microscopic animal you have seen? If you have any ideas as to its identity, jot them down and mail to the Microscope Editor, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York, N. Y.

A NET TO HOLD TINY ANIMALS

To keep specimens from being washed off the slide when it is irrigated, or to hold them still for examination, a tuft of cotton is placed on the slide

A network of cotton fiber, placed on the slide to restrict the movements of tiny animals, is magnified at right

easy way of applying stain to living protozoans and the like.

THE stain commonly used is neutral red, obtainable from biological supply houses and some of the larger drug stores. Make a weak solution by dissolving one tenth of a gram in 1,000 cubic centimeters of water. This is approximately equivalent to three grains (avoirdupois) dissolved in a quart of water. There are two ways of using the stain. One is to place a drop of it at the edge of the cover glass, and then persuade it to flow beneath the glass by applying a blotter at the opposite side. You can watch the staining action penetrate the infusorians and color the granules inside their bodies. Another way is to mix a drop of the stain with four or five drops of water containing the specimens, letting it act for a time, and then transfer a drop of the preparation to a slide.

The making of permanent slides of protozoans and minute many-celled animals is a process that might be classed as a sport, for the elements of uncertainty and surprise are prominent. Because of their smallness and delicate structures, and often their ability to fold up into something that resembles nothing in particular when anything happens to interfere with their normal activities, these tiny animals are not at all easy to mount.

However, a good protozoan slide is worth all the trouble involved in making it. The process involves, briefly, cementing the animals to the slide, killing and fixing them, staining, removing water, and applying the mounting medium and cover glass.

MAYER'S albumen fixative is used for fastening them to the slide so they will not be lost during subsequent handling. To make this fixative, beat the white of an egg until it is foamy, then pour it into a tall tumbler or similar container. Let it stand until a froth or scum has collected at the top. Transfer the clear liquid under the scum, to another container, and add to it an equal volume of glycerin. To prevent spoiling, add two grams of salicylate of soda to each 100 cubic centimeters of the mixture. Filter through cotton into a properly labeled bottle.

Clean several slides to remove grease, and place a tiny drop of the albumen fixative in the center of each. Spread this out with your finger into a very thin, even film. Set the slides aside in a dust-free place, if they are not to be used immediately.

Place in the center of each slide a drop of the water containing the organisms. Try to include as little sand and undesirable debris as possible. Inspect each slide with the microscope at this point, to make sure that it contains the desired specimens. Do not use a cover glass. Place the slides on a flat surface and let them dry until only a slightly moist spot remains where the water drop was. Now transfer them to the fixing solution, which kills the tiny animals and at the same time "fixes" their bodies so that they are not shrunken or distorted.

There are several preparations commonly used for fixing tissue, which may be employed on protozoans. One, Worcester's fluid, is prepared according to the following formula: Formaldehyde (10 percent formalin solution), one ounce; water, three ounces; and as much bichloride of mercury (corrosive sublimate), as will be dissolved.

BICHLORIDE of mercury is a powerful poison, so be extremely careful in handling it. It is obtainable in tablet form, two or three average-size tablets being sufficient for the amount of formaldehyde solution given above. The formaldehyde usually sold at drug stores is of 40 percent strength. Keep the solution in a bottle plainly marked "poison."

Another fixer you might try is a picric-alcohol solution made as follows: Water, forty cubic centimeters; ethyl alcohol ninety-five percent, forty cubic centimeters; and picric acid 0.16 gram.

Picric acid stains the skin yellow, so avoid handling it any more than is necessary.

Fix each slide for a half hour in Worcester's fluid, and then wash in several changes of water, over a similar period.

Various staining materials can be used. Eosin, haematoxylin, iodine, acid fuchsine, mercurochrome, and many other stains will give good results. Try using two stains together, such as eosin and haematoxylin. The stain can be applied by immersing the slide in a solution of it, or by laying the slide on a level surface and spreading a little pool of the stain over the area containing the specimens. A half minute or more will be required for complete staining. If the color is too deep, it usually can be reduced with alcohol.

AFTER staining, the final mounting can be accomplished by flowing a half-and-half solution of glycerin and water over the specimen area, letting this stand for a half hour, and then replacing it with pure glycerin, finally adding the cover glass. Remove excess glycerin with a piece of blotter or filter paper, until the glass is dry, and then seal the cover glass in place with gold size. Such a slide will last for a long time, but is not as rugged or permanent as a balsam mount.

Before balsam can be used, the specimens must be dehydrated. This is accomplished by leaving the slides for successive half-hour

periods in baths containing fifty-, seventy-, eighty-five-, and ninety-five-percent alcohol. It is necessary to remove the mercury that entered the specimens during fixing with the Worcester fluid. To do this, add iodine to the seventy-percent alcohol bath until it is colored fairly deeply. Usually, ninety-five-percent alcohol is strong enough for the final bath, although absolute alcohol is better, particularly in a damp climate.

When all water has been removed, flood each slide with xylol for a minute or two, drain, place a drop of balsam in the center, and lower the cover glass into place.

You will find it instructive to experiment a little with this process. For instance, you may be able to produce excellent slides by putting them directly into ninety-five-percent alcohol in which some iodine has been dissolved, after staining and rinsing. Change to a second ninety-five-percent

alcohol bath, (without iodine) for fifteen seconds or so, and then to the xylol. Leaving the specimens too long in alcohol will remove some stains, such as eosin. In transferring slides from water directly to ninety-five-percent alcohol, or from the strong alcohol to water, diffusion currents which might prove troublesome are avoided if the slide is plunged quickly beneath the second fluid.

For handling slides in minimum quantities of solutions, special slide-staining dishes or jars, with grooved sides, are available. Just as satisfactory are small graduates or jars whose inside diameter is slightly more than one inch. Two slides, back to back, can be inserted into them without fear of damaging the specimens.

THIS process of mounting protozoans will, you will find, at the same time serve to trap diatoms and other interesting plant forms as well as microscopic animals. Although it may be desirable to have the specimens segregated, there is no particular objection to having diatoms and amoebas, or other animals, on the same slide. They live together in nature.

Your adventures in a drop of stagnant water may lead you to wonder about the water that you drink. If your relish for the water will not be disturbed by making surprising discoveries about it, you can have fun in making a microscopic examination.

If you merely take a drop of water from the faucet and put it on a slide, the chances are several million to one that you will find nothing. It probably is a fact that every city water supply in the world contains micro-örganisms, and frequently other interesting things such as insect legs. To capture these objects, it is necessary to strain the water through very fine silk. Water is allowed to run through the silk for several minutes, after which the layer of sediment is washed from it to a microscope slide. You can make a holder for the silk from a ten-cent strainer.

The finding of rotifers, snake-like nematodes, pieces of insects, diatoms, algae, and similar things in your drinking water does not indicate that you should stop drinking it. Such creatures usually are dead when found, and the insignificant amount of meat or vegetable matter you consume by drinking the water means nothing at all. Anyway, your body is equipped with defensive forces to handle such organisms as may enter it in food and water, and by other routes.

Matchless Flowers FOUND WITH YOUR Microscope

Organism in Vast Variety of Forms Proves a Fascinating Study—How to Mount Diatoms for Your Collection

By
BORDEN HALL

POPULAR SCIENCE MONTHLY AUGUST, 1933

NATURE'S microscopic flower excel in beauty the rarest and most exotic of our highly cultured plants. An orchid or an iris appears crude and unfinished by comparison with the intricate and fascinating pattern of a diatom as seen under a microscope.

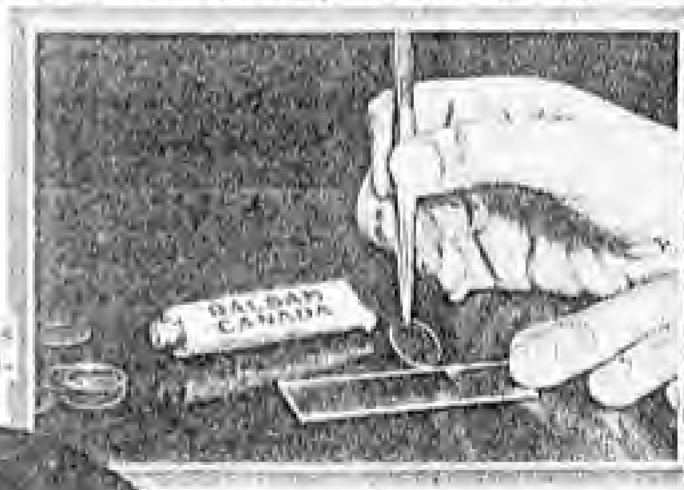
Nearly everyone has heard of diatoms and knows vaguely that they are tiny plants too small to be seen by the unaided vision. Few realize however, that this widely scattered and prolific family can be found in a vast number of forms, each of which is endowed with almost unbelievable beauty. Thrilling adventures and sights undreamed of await the owner of a little microscope having a magnifying power of from 300 to 350 diameters.

So large and luxuriant is this garden of nature that scores of men have made it their life work to study and classify the things they found in it. More than 10,000 different kinds of flowers have been discovered and classified in more than 1,200 species. The work still goes on. In no other field can the microscopist find such variety of form and color. One diatom may resemble the steering wheel of your car; another may suggest an intricate ladder, and a third look like a series of delicately forged gratings.

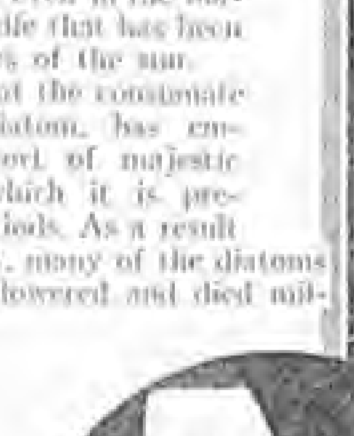
The diatom grows wherever there is moisture and light. Aside from this, it has no particular habitat. It is found at the seashore, in the bottom of creeks and ponds, adhering to moist rocks and marine plants, and even in the bottom of a mud puddle that has been exposed to the rays of the sun.

Nature, jealous of the consummate beauty of the diatom, has embalmed it in a sort of majestic sarcophagus, in which it is preserved for long periods. As a result of this strange fact, many of the diatoms we shall examine flowered and died millions of years ago. This sarcophagus is composed of a hard, flintlike compound of silicon. Ordinary sand is such a compound.

IF THE bottom of a large puddle, several weeks old, is carefully scraped some interesting diatom specimens may be found. We cannot, however, see them with our unaided eyes, for a comparatively large diatom measures only about one two-hundredth of an inch in diam-



A cover glass is placed over the diatom specimen and it is tightly seated down with Canada balsam


Banded diatoms, described in the text, are here seen as they appear when greatly magnified


Diatom specimens taken from the mud of a pond are boiled in acid and rinsed before being mounted

eter. The mud you have taken out of the puddle should be drained free of water and a small bit of the residue placed on a clean slide and carefully examined.

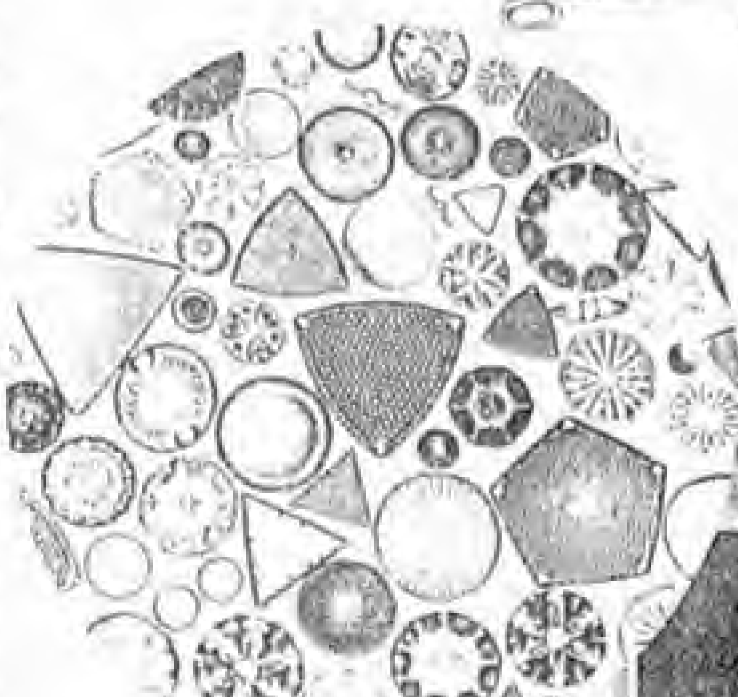
This search may reveal no diatom for it may be that, in the puddle you chose, none was growing. In that case, it will be necessary to find some stagnant pond or sluggish creek and scrape the bottom for mud. Not all of these interesting plants, however will be found on the bottom, for a number of the species cling to other and larger plant life that grows in water. Often scraping the underside of a marine plant will bring to light diatoms fastened to the leaves by gelatinous stalks. Those who live near the sea will undoubtedly find specimens attached to seaweed.

Once a source of diatoms is discovered, the real fun begins. Each specimen appears different from the others because of the extraordinary variety in this family. Objectives of both high and low power may be used. Indeed, many microscope enthusiasts claim that better and more exciting views of the diatom may be had with the lower powers. The writer however, would advise the use of each.

When we view a diatom with the high-powered objectives, it is necessary to focus and refocus a number of times, for the thickness of the specimen may be such that one part cannot be brought into perfect focus without blurring another part. Thus examination is carried on progressively at different levels.

An ordinary medicine dropper or a pipette often is used by the microscopist in transferring small amounts of mud and water containing diatoms to the slide for careful examination

IF LIVE diatoms are discovered in the bed of a pond and we have a plentiful supply of them, it may prove interesting to place a bit of water and some of the mud in the depression of one of the special microscope slides mentioned in my article last month. Many of these marvelous little plants have the power of locomotion and we may experience the rare delight of seeing them propel themselves through the water. Some have a rather lively motion that will carry them past our vision in a zig-zag course.

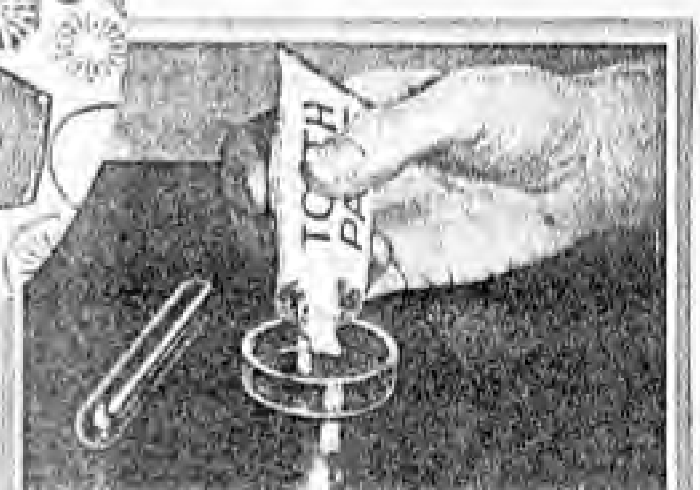


In the study and examination of diatoms, the thing that will strike us most forcibly will be the exquisite and delicate patterns of the tiny plants. It is as though a thousand great artists had been turned loose and told to draw and color a multitude of lacelike designs using every known geometrical form. The show is absolutely unending for even though we should spend a lifetime examining these specimens we could never exhaust their infinite variety.

Diatoms, that is the very old, old diatoms that flowered millions of years ago, have a number of important industrial duties. We buff our silverware and often brush our teeth with these old, but still perfectly intact, little plants. Also, in the form of kieselguhr, a fine powder, they are used as the absorbents in the manufacture of nitroglycerin and the preparation of dynamite. We also find that much of this diatomaceous earth or kieselguhr, is used in the manufacture of non-conducting materials for heat and sound resistance. This comes in the form of wall board. Hence we have wall board made of microscopic flower gardens that perished countless ages ago!

One of the world's greatest deposits of diatomaceous earth was found in Virginia. This deposit runs for a distance of many miles and in some spots is forty feet deep. As it has a mild abrasive action and will not scratch, a great deal of this earth is used in polishing and cleansing agents.

The alert microscopist does not need to suffer for want of diatomaceous earth. It may be obtained cheaply from microscopic supply houses or, in many cases, it may be found in the home. Not all tooth pastes and powders contain this excellent polisher but many of them do, with the result that these fossilized dia-



Fossilized forms of flowers that lived millions of years ago may be found in your tooth paste. Diatoms may be removed from the water in which they abound by filtering, as shown below

toms can easily be brought to the stage of the microscope. Silver polish also often contains such earth as its principle ingredient and hence contain diatoms.

EACH sample of toothpaste or silver polish examined in the search for ancient diatoms, must first be dissolved in a small amount of water. The excess water is then filtered off through very fine cloth or by means of chemical filter paper. The residue is transferred to a clean slide and placed on the stage of the microscope. Two or three drops at a time is sufficient. As the slush is examined, the worker moves it about with the needle that was described in the first installment of this series. As he does this, the microscopist will feel very much like the archaeologist who delves into old ruins seeking the artifacts and records of ancient life. The ruins which the microscopic worker wanders amidst, however, are far older than any ruins that men have left for the archaeologist.

IN CULLING through these botanical graveyards, one of the low-powered objectives may be used since in this way the area of examination is increased and the search speeded up. After interesting specimens have been found, the objective may be changed for one of higher power. This will bring out details and reveal to us the strange fact that these million-year-old diatoms were no different from those living today. Indeed, one can find diatoms exactly like them at the bottom of any stagnant pool.

Let us take a good look at a living diatom. For this purpose a drop of water must be used. No diatom can exhibit natural habits unless placed in water which is its natural environment. Examine it first with

the low-power objective, and then with the high-power. The patient observer will discover many interesting things about diatoms. Each individual is encased in what is known by the botanist as a frustule. If it is examined closely, it will soon be seen that the cell wall is made up of two similar valves nearly parallel to each other, and each provided with a connecting band projecting from it at a right angle.

A PILL box and its cover give us a good idea of the way in which one of the valves of a diatom fits inside the other. In a sense, a diatom is much like an animal growing inside a pill box—the larger the animal becomes, the more the pill box expands. As the protoplasmic contents of a growing diatom increases, we find the valve expanding to take care of the growth.

No student can gaze upon these intricate and wondrous forms without being seized with a desire to prepare specimens in mounted form. Once a supply of the living diatoms has been discovered, this is an easy matter. The mud from a creek or pond bottom that we learn from examination contains a large number of diatoms, is placed in the bottom of a small wide-mouthed glass vessel. A strong solution of either hydrochloric or nitric acid, one part acid to one part water, is placed over the mixture and the whole boiled slowly until part of the water and acid evaporate.

The liquid that is left is carefully siphoned off, care being taken to prevent the end of the siphoning tube from reaching the bottom of the container, as all of the specimens will settle to the bottom after the boiling and your siphon may easily drain off the very finest specimens you have collected.

Over the residue, clear water is poured and this in turn is siphoned off after the earth, containing the specimens, has been given time to settle to the bottom of the container. As the next cleansing operation, the earth is boiled slowly in carbonate of soda and after an hour or so the heat is turned off and the earth permitted to settle. This solution is siphoned off and replaced with clear water. After this last washing with water and final siphoning, the specimens are ready to be mounted.

Just a speck of the moisture remaining in the bottom is transferred to a clean microscope slide. It is left there until all of the moisture has evaporated. Naturally, this operation may be speeded up by slow heating and it is really best to do this to be sure there is no water in the finished mounting for if any remains it will spoil your work.

AFTER the speck left on the slide has been thoroughly dried, it is covered with a thin layer of dilute Canada balsam which is permitted to set after a thin cover glass has been put in place.

In the preparation of diatom slides in this manner, the worker should not stop at one slide. In a single teaspoonful of the right kind of mud, there will be found enough diatoms for many slides. Indeed, each little speck of dirt will contain a number of them. For that reason, at least two dozen slides should be prepared at a time. Even then, you will have only a very small number of the large family of diatoms.

As time goes on, our collection of slides will grow until we have so many boxes of slides that it will be advisable to make some kind of a cabinet for them. In such a cabinet, they can be classified so they will be instantly available. The cabinet need not be elaborate. In fact, a cabinet made from cigar-box wood, of the general type shown at the head of this article, will meet the needs of most amateur microscopists for years to come.

Invisible Chemists *found* *with a* MICROSCOPE

How Mold Forms Found in the Woods Are Studied Under a Lens . . . Staining Specimens to Make Their Structure More Easily Seen . . . Building Your Own Small Arc Lamp with which to Take Pictures

POPULAR SCIENCE MONTHLY OCTOBER, 1933

AMONG the most fascinating, and perhaps among the most useful, forms of microscopic life known to man are the mycetozoa, moldlike organisms found in the deep woods. Their swift life cycle presents a multitude of forms and a perfect riot of color. At certain stages, these tiny creatures make surprising balloon journeys through the air. It is a form of life so varied, so alive, and so baffling that we could spend years and years investigating it without, probably, adding anything new to the vast number of facts already known about it.

If you live in the country or on the outskirts of a city, it is likely that you will be able to find millions of mycetozoa in your back yard. After you have found them, you will have trouble deciding whether your captives are plants or animals for the

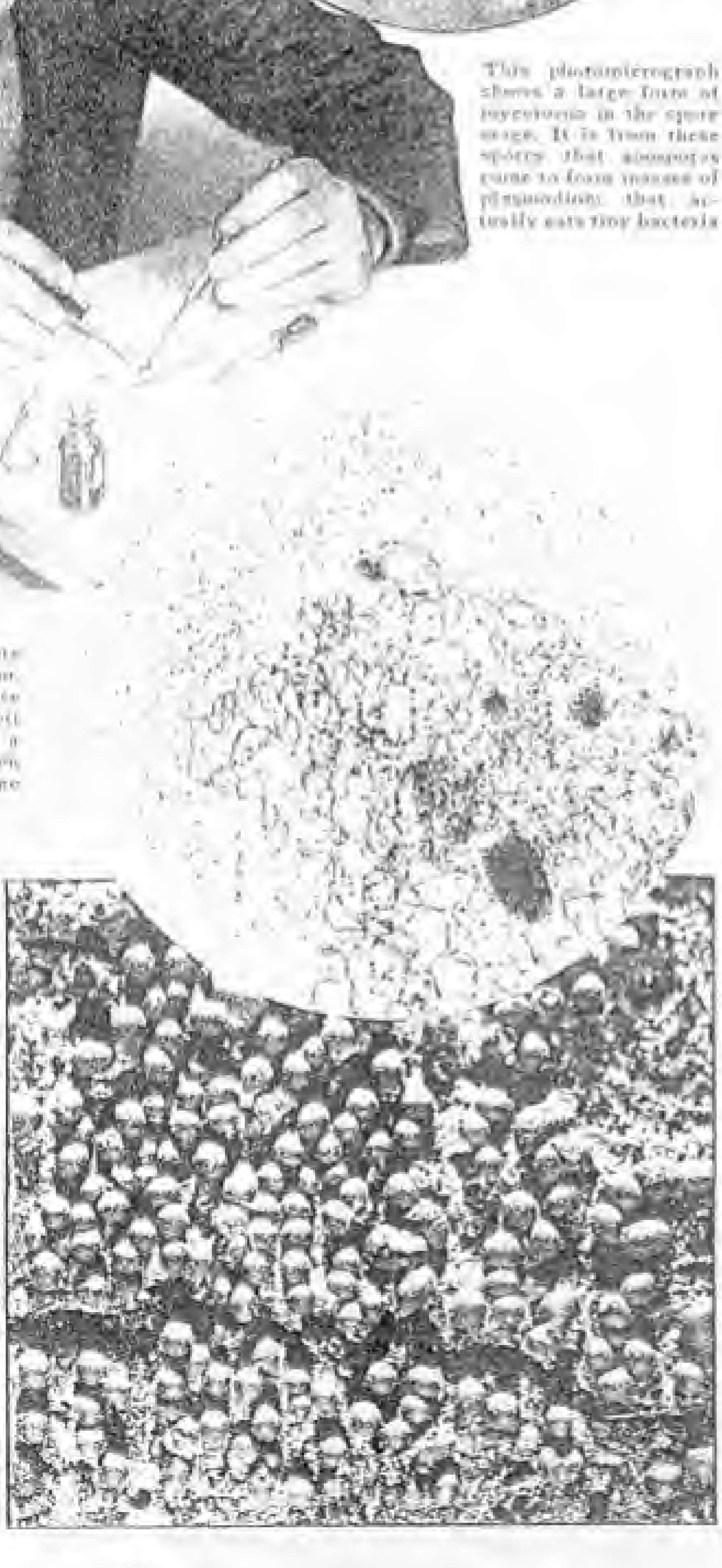
By BORDEN HALL

Above, tweezers are used to place a bit of mycetozoa on the slip glass beneath the microscope's lens. At left, haematoxylin and dropper which are used in staining the tiny specimens

This photomicrograph shows a large form of mycetozoa in the spore stage. It is from these spores that zoospores come to form masses of plasmodium that actually eats tiny bacteria

To see clearly the minute structure of plasmodium, a needle and scalpel are used to place a small bit of it in the center of a glass slide, which is then put on microscope's stage

Photomicrographs by Philip O. Gravelle, F.R.P.S., F.R.M.S.



ENLARGED SPORES OF THE SLIME MOLD

In circle, photomicrograph of slime mold magnified 150 times, and showing network of fine, branched strands mixed with spores in the sporangia of many myxomycetes. At right, a photomicrograph of bark fungus enlarged six and a half times. The mushroomshape of spores is visible

mycetozoa pass through a life cycle that is extremely confusing both to the zoologist and the botanist. Today many authorities consider these mites as animal but admit that, in their system of propagation, they are vegetable. As a result, the statement that they are animals is not universally accepted.

To find the mycetozoa, we enter the woodlands and seek a low, damp spot where rank vegetation is growing about fallen and decaying trees. Such is the home of the mycetozoa, of which there are some 500 classified varieties. It should be kept in mind that the tiny animal we seek has several forms and the microscopist must be able to recognize the one that is most easily found. On the surface of decayed logs look for a white slimy substance known as plasmodium, which is a mass of protoplasm formed by tiny organisms and strongly resembling the white of an egg. We may be fortunate enough to find it on the surface of a log, or, if not there, we may have to dig into the wood beneath the bark to find it living in strange, active colonies.

Of course it can be seen with the naked eye and may be found in patches a foot square. This plasmodium consists of a family of mycetozoa in its most important life stage. If the hunter has time to spare and will watch this mass, he will see that it has the power of locomotion. As a matter of fact, it is composed of a large army of a particular kind of mycetozoa that is characterized by the tendency to congregate in this strange manner.

For the purpose of capturing a number of the family, we have brought with us a clean piece of white blotting paper. When the plasmodium is found, the paper is dampened and some of the slimy substance is placed upon it. Arrangements must be made to protect the paper so it will not dry out while you are taking it home. If the journey is a long one and the day is hot, it will be necessary to dampen the blotter occasionally to make sure the plasmodium does not die.

Once home, a slip glass is prepared and some of the slimy mass is transferred to it and placed under the little 300 or 350-power objective of your microscope. If, however, you have a higher-powered objective, it will be well to use it for this investigation, provided your technique is equal to the manipulation of a high-powered instrument.

Upon looking at the mass of slime and water, we see that it is made up of myriads of tiny forms each having a tail with which it swims rapidly hither and thither. These are the zoospores that represent one of the life stages of the mycetozoa cycle. The zoospores, pure protoplasm, are provided with the rudimentary organs necessary to their survival in this particular environment. In some of the common species, the zoospores have, beside their tiny tails, vacuoles which really amount to crude digestive organs. What could such a tiny speck eat? Into a fantastically imperfect mouth, these minute creatures suck various sorts of bacteria. Indeed, the patient observer will note that as long as the zoospores are in a suf-

ficiently wet medium a constant stream of fluid passes through their diminutive systems. It is from this bacteria-laden stream that sustenance is secured.

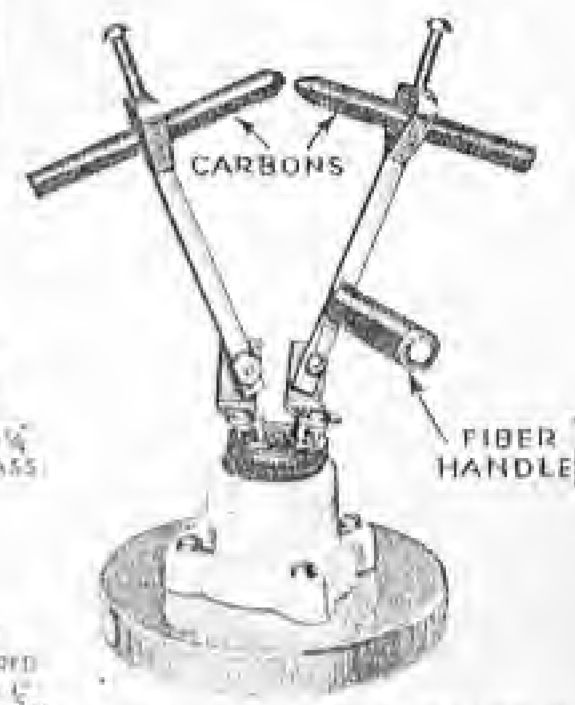
While in the woods, we had an opportunity to pick up another form of this curious life. In logs that have reached the extreme point of decay, we may see a fine red and velvety powder. Touching it with our fingers, we find it is light and fluffy and discover that much of it will fly into the air before the slightest breath. Some of this should be taken home in a small glass bottle, placed upon a clean slip glass, and set upon the stage of the microscope. Looked at in this manner, we will be surprised to see tiny red mushrooms, each sitting on top of a gossamer stem. It is this funguslike stage in the life cycle of the mycetozoa that makes scientists wonder whether it is a vegetable or an animal form.

It is from this interesting mushroom, or spore, stage that the mycetozoa get a new lease on life. The wind lifts the tiny spores and distributes them far and wide so that some are fairly sure to fall upon moist spots where the whole mysterious life cycle begins again!

Naturally in their balloon journey, millions of these spores fall upon dry soil and perish. Countless other millions, however, reach spots suitable to their existence and propagation. Immediately upon coming in contact with moist and partially decayed matter, the spore drinks water and swells up. This process we can observe directly by placing a bit upon a damp surface and watching closely. The tiny spores become larger and larger until finally they burst and out pop slimy bits of protoplasm which turn out to be zoospores. These zoospores then congregate to form the bacteria-eating masses of plasmodium.

To keep the plasmodium alive, care must be taken to see that the bits we brought back from the woods are permitted to live on a small piece of the partially decayed and damp wood to which it originally clung. If this is done, we shall see, in time, that colonies of zoospores are undergoing severe changes. The masses, drying out, change form, change color, and finally we see little spores begin to appear, their number rapidly increasing until the whole mass is composed of nothing but spores. Each spore is a tough little bag made for the purpose of preserving the life of the protoplasm it contains until it can again be brought into contact with decayed vegetable matter and water.

It should be remembered that we have been observing the life cycle of some of the more common and abundant members of this large family. Indeed, the family is so large and has such a wide variety of habits that the inexperienced microscopist may fail to recognize many of them.



Pictures showing clearly how to construct an arc light of your own with which to see the tiny specimens of mycetozoa when placed under the lens of a microscope

The million and million of microscopic mushrooms that are produced from the plasmodium offer an absorbing course of study. Before they are fully matured, we see that they range in color from silver to pink, and resemble, under the glass, a basketful of lovely pearls. This exquisite stage, however, is of brief duration. If they are maturing in the proper medium, we shall see that, in some mysterious way, they appear to take root while slender, delicate little stems support them. Next, important changes occur and the beautiful luster of the skin is destroyed. Pucks and lines appear and we see what looks like a golf ball delicately set upon a slender tee.

Naturally we shall want to add some of these specimens to our growing collection. To do so, we must first understand that the spores are of such a nature that, should we place them under a cover glass and seal them in, they would be crushed and rendered useless. So we must build up a cell.

A CLEAN slip glass is placed upon the turntable described in a previous issue (P.S.M., Feb. '33, p. 47) and a circle of Canada balsam is made with a brush and permitted to dry. More circles are added, one on top of the other until a cell wall, sufficiently high, is built up. The bottom of the cell is then covered with another dab of Canada balsam and while the balsam is wet a few of the spores are gently blown in from another slip glass. The cover glass is sealed in place with asphaltum or balsam after the balsam in the cell has dried.

Another common family of mycetozoa, called Stemonitis Splendens, offers a rare form of beauty. Its dense form clusters that reach an inch high. Stemonitis Splendens is found on the shaded margin of a small pool. Some of the tiny stems, carefully collected, are placed in a box containing moist earth and carried home. The true beauty of this member of the family can only be appreciated through the 350-power objective.

The mycetozoa, in spite of their tiny size, play an important part in the world. They not only accelerate the decay of vegetable matter but they also break down organic combinations of chemicals and transform them into necessary fertilizers. These diminutive creatures are proficient chemists and it is conceivable that the human race owes its life to them. At any rate, they form a fine subject for investigation by the amateur.

As many readers, who have been taking photomicrographs, have written me of the trouble they have had in securing proper illumination of the microscope field, it seems desirable to describe a most valuable accessory.

PHOTOMICROGRAPHY, in its elemental aspects, is the same as ordinary photography; that is, the better the light, the shorter the exposure and the better the picture. While a 500-watt lamp, costing $4.00, will serve this purpose nicely, the little arc light, a description of which follows, is still better and may be put together for a few cents. The carbons are of the five-sixteenths-inch variety and may be bought at any photographic supply house. They are held with set screws in two brass arms bent into the shape shown from one-quarter by one-eighth-inch stock. Through the medium of two small angle pieces, these holders are screwed to the prong members of an ordinary light plug. When they are pressed down into a receptacle, the carbons are brought into the correct position for striking.

Either an electric toaster or the heater element from a bowl heater is used in series with the arc light to control the current. A small

fiber handle is screwed on one of the brass members so that the arc may be struck and subsequently regulated.

It is best to place a tin housing over the arc when it is finished. The light escapes through a small opening in the front. A crude metal reflector placed back of it will also help. Glass will not do because it cannot withstand the heat.

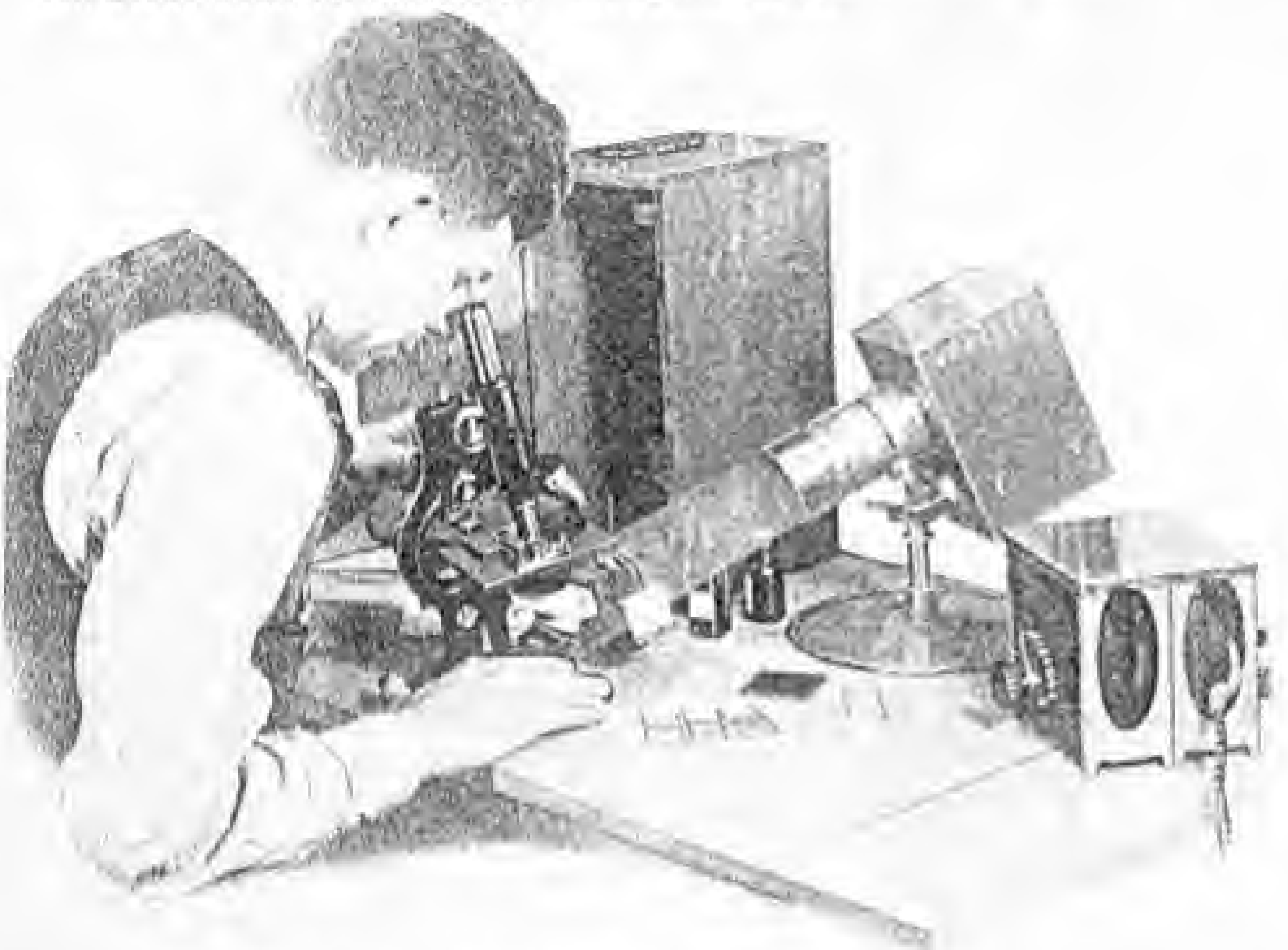
This light is rich in violet rays and it will be found possible to take much better photomicrographs with it. The worker, however, is warned to shorten his exposure time if he has been using ordinary electric illumination.

Microbe Hunting WITH YOUR MICROSCOPE

POPULAR SCIENCE MONTHLY SEPTEMBER 1934

How to Find Germs, Mount Them, and Study Their Life History Beneath Your Lens Is Clearly Described Here

By
Morton C. Walling



LIGHTING A MICROBE SPECIMEN

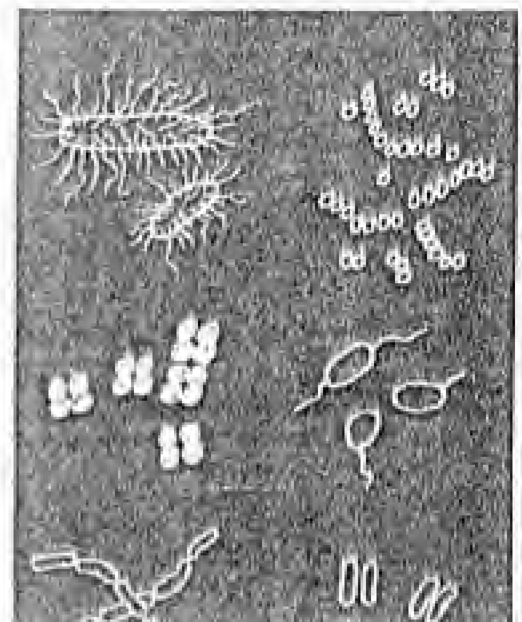
Having mounted a solution containing microbes, as described in the text, the slide is placed beneath the lens and illuminated by an enclosed and directed light as is shown in the illustration above

IF THE microscope could make visible nothing except the tiny plants known variously as bacteria, microbes, or germs, it still would deserve its position as the leading tool of modern science. In the first place, it was the microscope that revealed the presence of these organisms and made possible the researches that showed them to be plants rather than animals. By magnifying bacteria in milk, meats, and canned goods, the microscope helps to prevent the sickness that results from poisons. By revealing germs occurring in the blood, waste matter, or stomach contents of sick persons, it enables physicians to identify diseases and wage successful battles against them. This magic instrument also has been used to make visible, in coal and other fossil remains, germs that lived millions of years ago!

There probably is as much variation in the sizes of bacteria as there is in plants of the garden or field. Scientists have reason to believe that there are vast numbers of microbes so small that they never will be seen through the microscope, at least not through one that works on present optical principles. On the other hand, there are many varieties of bacteria that are, when compared with others of their kind, very large; so large they can be seen through the average amateur microscope that magnifies a few hundred diameters.

You cannot simply train your microscope upon a drop of stagnant water or a bit of decaying meat and see the bacteria that are living in it. You have to go about this business of microbe hunting systematically, employing stains and special methods to render the tiny germs visible. After you have gone through the process once, you will be surprised at the speed and ease with which you thereafter can stain and mount bacteria for observation. You will find this process one of the most fascinating in microscopy.

Equipment for a microbe hunt does not have to be elaborate. A few clean slides and cover glasses; some denatured or, better still, absolute ethyl alcohol; a bottle of Loeffler's methylene blue stain; some liquid petrolatum or Canada balsam for mounting, and the usual tweezers, medicine droppers, and glassware used in most slide-making operations, are about all that you need to secure slides of bacteria.



FORMS OF BACTERIA. Here are two of the commonest forms of bacteria and those you will be most likely to encounter. The rod-shaped ones are bacilli and the spherical ones are cocci. Others spiral in shape are called spirilla

You can find bacteria almost anywhere. Your mouth is swarming with them. The water of the fish bowl has hundreds of them in every drop. They are present in milk, buttermilk, cheese and, of course, in spoiled foods in great numbers and are easily found and mounted.

Your mouth is a fairly well-stocked botanical garden, as the following procedure will demonstrate:

Lay out one or more clean glass slides and cover glasses. Incidentally, a "clean"

slide does not mean one that merely is wiped a few times with a cloth. You must remove every trace of dirt and grease, particularly grease, if you want the best results. A simple method of cleaning a slide or cover glass is to wash it first with soap and water and then scour it with a greaseless household cleaning agent. Finally, polish the glass with a clean cloth such as a well-washed linen towel. When the glass surface is perfectly clean and free of grease, a drop of water placed on it will spread out into a thin film. It is a good idea to pass the polished slides and cover glasses two or three times through an alcohol or gas flame, just before using, to remove traces of grease. Be careful not to hold them in the flame long enough to cause warping or cracking.

Touch the tip of your tongue lightly to the center of one of the clean slides. Allow the spot of moisture to dry, or heat the slide gently to hasten drying. Lay the slide face up—that is, with the side to which you touched your tongue, uppermost—on a watch glass or other support. Let a drop of alcohol fall on the center of the slide. When it has spread out into a thin film, strike a match and touch the flame to the edge of the alcohol layer. The burning alcohol fixes the bacteria that were transferred to the slide surface from your tongue. In other words, the treatment kills the germs and preserves them in their natural form.

Loeffler's methylene blue is a satisfactory stain for coloring bacteria. You can purchase this preparation at biological supply houses and some drug stores, or you can make it as follows:

Add to thirty cubic centimeters of alcohol all the methylene blue it will dissolve. Mix this with 100 cubic centimeters of distilled water to which has been added two drops of ten per cent potassium hydroxide solution. (To make a ten per cent solution of potassium hydroxide or any other salt, mix one ounce of it with enough water to make ten ounces of solution). You will find this stain useful in preparing all kinds of specimens for the microscope.

Place one drop of the methylene blue solution on the material to be stained and let it remain for one to two minutes. You may get better results by diluting the stain with three or four times its volume of water, and letting it act for a longer time.

Wash the stain off by letting tap water run over it, and dry the slide. A quick and easy way of removing the water is to use a sheet of filter paper as a blotter, being careful to *press* it against the specimen, and not to wipe it across the glass. It will pay you to become acquainted with filter paper, for it can be used for many things in the microscope laboratory, its chief value of course being as a filter for stains and other solutions from which you desire to remove solid particles.

Although the slide can be examined as it is, it usually is desirable to add a cover glass that is held in place by a mounting medium. For this medium you can use Canada balsam, the result being a permanent slide. Some expert microscopists prefer liquid petrolatum, an oily substance that is said to have better optical properties than balsam. You can obtain it from a druggist. Ask for the heavy grade, in a dropper bottle. Place a small quantity of the petrolatum, just enough to spread out evenly beneath the cover glass, on the stained specimen, and add the cover glass. There should not be enough of the petrolatum to ooze out around the edges. If you want to make the mounting permanent, simply apply with a small brush gold size about the edge of the cover glass.

You probably will not be able to see anything on the slide when you examine it with your naked eye, except perhaps a slight bluish tint; but when you examine the slide with your microscope, at a magni-

• HOW TO PREPARE, STAIN, AND MOUNT A BACTERIA SPECIMEN FOR OBSERVATION UNDER YOUR MICROSCOPE •

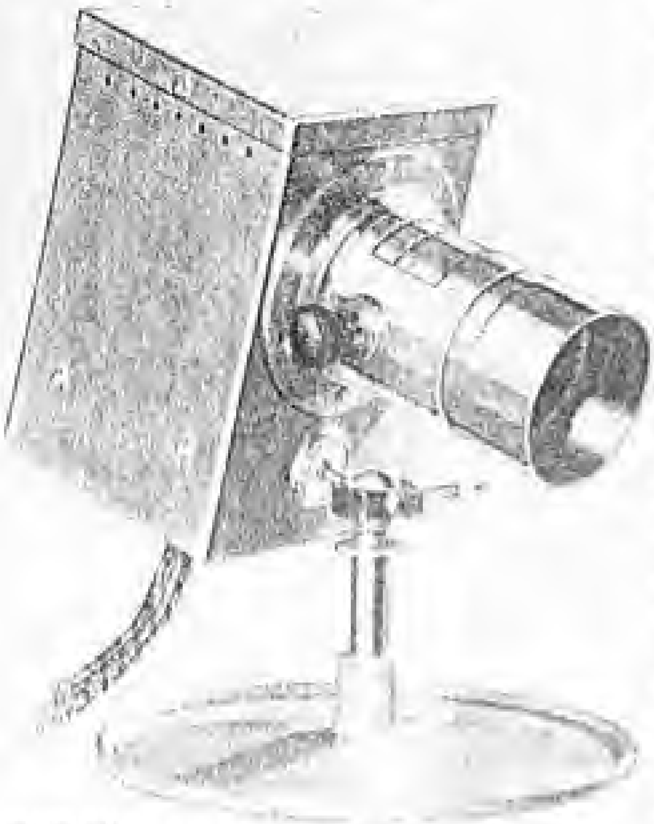
1 Preparing bacteria for observation under a microscope. A small quantity of bacteria material is smeared on a slide

2 When the smear is dry, alcohol is burned to fix it

3 Loeffler's methylene blue preparation is applied for two minutes to stain the specimen

4 After the stain is washed away with clean water, the slide is dried with filter paper

5 A tiny bit of petrolatum is placed on the smear. Add cover glass and specimen is ready



HOMEMADE LAMP. This laboratory microscope illuminator was made largely from odds and ends. It is powerful enough for high powered magnification. Instructions for making given in the text

fication of 250 to 500 diameters, you find that your mouth contained more than teeth.

The large, irregular stained patches that are visible in the microscope field are bits of tissue or food that were in the saliva. In addition you see a lot of little specks. Some are round, others are two or three times as long as they are wide. You move the slide a little. Here is something! A dozen or so little balls are strung together, like beads on a string; and here is another string, but the beads are rod-shaped instead of spherical.

These isolated specks and strings are bacteria, the tiny plants that were in your mouth. Probably most of them are harmless, because your mouth normally is swarming with them. Probably, too, some of the germs are of the pathogenic or disease-producing type. But do not let that worry you, for the average healthy mouth contains many harmful bacteria that are prevented from doing damage by the normal resistance of your body.

If your microscope does not reveal the bacteria distinctly, try improving its performance with filters, or by adding a substage diaphragm as described in a preceding article, (P.S.M., June, '34, p. 40) if this useful accessory is lacking. Perhaps a different stain, such as carbol fuchsin, will work better in some instances. After you have determined what to look for, you can distinguish bacteria with a magnification of only 100 diameters. A good rule is to look first for the chains of rods or spheres.

You can find bacteria almost anywhere, by following the preparation method outlined. In some cases it will be necessary to introduce variations. For example, in the preparation of milk specimens, which make excellent subjects for the amateur, you must remove the fat and manipulate the stain so that the best contrast is produced.

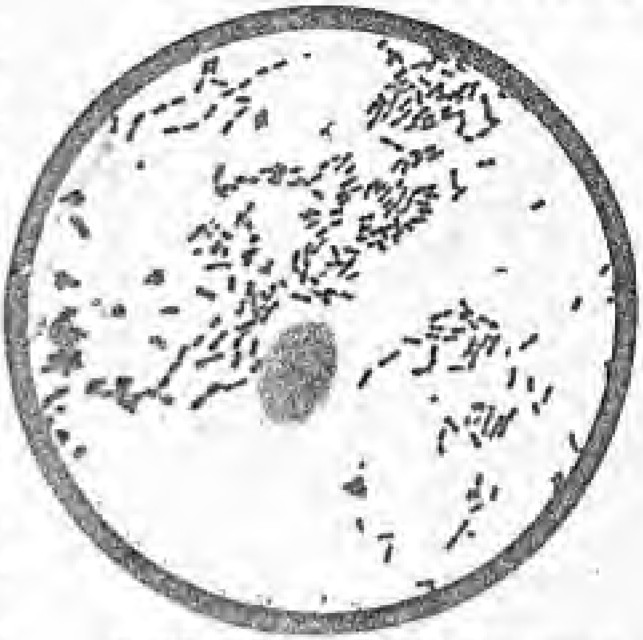
Preparation of milk for bacteriological examination can be outlined in steps as follows:

1—Make a thin smear of milk or cream on a slide.

2—Dry gently over a flame.

3—Cover the specimen with a few drops of xylol for two and one half minutes, and then drain off. This removes the fat.

4—After xylol has evaporated, add several drops of acetone and let



YOUR OWN BACTERIA. Touching the tip of the tongue to a slide deposited the bacteria seen in circle. The dark oval spot is the nucleus of a dead cell

remain for about three minutes. Instead of acetone, you can use alcohol for two to five minutes, or until the smear has lost its milky appearance and become clear.

5—Stain with Loeffler's methylene blue for about two minutes. Rinse in ordinary water.

6—Cover the smear with alcohol for one minute. This bleaches out some of the stain, affecting that in the bacteria less than in surrounding material.

7—Mount in liquid petrolatum or other medium.

8—Label, listing source

MAKING A LIGHT FOR YOUR OWN MICROSCOPE

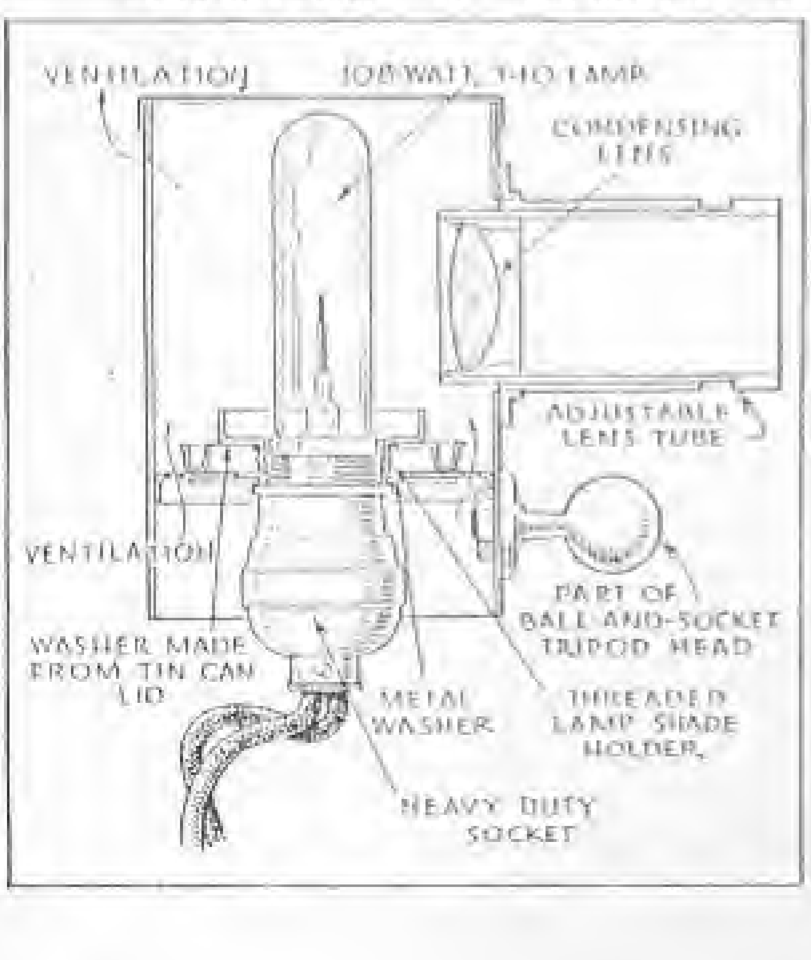


Diagram at left shows the manner of constructing a laboratory-type lamp at a fraction of the cost of a ready-made article. This gives you a light similar to that widely used in research laboratories

The best way of assembling the homemade illuminator is shown in the two illustrations above and at left. The lens is held by the wire spring shown in the foreground. The screw-on sunshade is in front of lens tube

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of material, stain used, and results obtained.

The presence of bacteria in milk does not mean that it is unfit for use. Dairy companies make no attempt to remove all bacteria for the simple reason that it would be impractical if not impossible. They simply strive to keep the number down to a safe maximum. Probably, too, many of the bacteria you observe in milk were killed by the Pasteurizing process.

You will find it a fascinating adventure to look for germs in all kinds of materials. If you happen to cut your finger, make a blood smear and stain it to reveal the bacteria. Perhaps you will be lucky enough to find a white blood corpuscle that has devoured a number of germs. It is by such means that the white corpuscles rid your body of disease-producing organisms.

In examining the juices of canned fruits, you may encounter tiny specks that resemble bacteria, but which are in fact tiny yeast plants. A microscopic cruise through a drop of juice from canned peaches revealed thousands of tiny yeast cells but not a single bacterium. The peaches had been opened several days before, but showed no signs of spoiling. Later they fermented. Generally you can distinguish yeast cells by their oval shape and comparatively large size, and the fact that many of them carry buds that are of the same general shape but smaller in size. Like bacteria, yeast cells collect in strings; but frequently these strings are branched, and some of the individual cells exhibit branching buds of smaller size. In bacteria strings, the individual plants are of about the same size, and are not branched.

THE botanist will tell you that bacteria are the smallest and simplest living things known, consisting of single cells whose protoplasm seems to be organized hardly at all. It would require 50,000 of some of the ball-shaped bacteria to extend one inch. This means that each bacterium measures about the same as a wave length of green light, so that it can just be seen by the microscope.

While some germs cause deadly fevers, others live in the roots of plants and manufacture nitrogen so necessary to plant growth. For every germ that grows in spoiled food and manufactures a poison so powerful that mere tasting of the food may cause death, there is a tiny organism that is working on waste animal and vegetable material, reducing it to a state where it becomes a useful part of the earth again, ready to start once more on a cycle in which it will serve as part of a living plant or animal.

Some bacteria live in the air for at least part of their lives, while others cannot exist in the presence of oxygen. All bacterial forms reproduce by simple fission. That is, one of the cells splits across the middle to form two new individuals. Sometimes these cells hang together until long strings of them, such as you saw in the saliva of your mouth, are formed. Others produce a jellylike material that binds the individual germs into masses or colonies which when conditions are right, become large enough to see with the unaided eye. A common way of identifying or studying bacteria in the laboratory is to cultivate them in colonies and then observe the color

BACTERIA FOUND IN MILK. In the upper circle are harmless bacteria in Pasteurized milk. Above, buttermilk bacteria

of the colony, as well as the shape and other characteristics of the individuals forming it. When conditions for growth are unfavorable, a bacterium may secrete a tough shell that encloses it, thereby becoming a spore. Some spores are so resistant that they can be boiled in water for hours without causing the death of the encased individual.

Doubtless you have heard the story of how a single bacterial cell, provided with all the food necessary, would grow in a few days into a living mass larger than the earth. Of course this can never happen, but you can prove that it might, by calculating how many individuals would be produced in a week by a species whose individuals divide every half hour, assuming that none of the germs die.

IN GENERAL, bacteria are shaped like balls or like rods. They may be equipped with one or more cilia or hairs. The rod forms may be bent and twisted like corkscrews.

Because illumination is one of the most important things to consider in connection with the microscope, you may be interested in construction of a laboratory-type lamp. This form of illuminator is used widely and is valuable for photomicrography and microprojection. You can build it for about one tenth of what you would pay for a ready-made lamp of similar characteristics.

The lamp consists of a 108-watt bulb in a housing that is fitted with a sixty-millimeter spherical condenser for concentrating the light on the microscope slide. The lamp operates at six volts and consumes eighteen amperes of current. That means that a transformer must be used to step down alternating current, and a suitable resistance used for direct current.

ASSUMING that you have a six-volt source of current available, your problem is to combine the bulb and condenser into a convenient microscope accessory. The photographs illustrate a form of lamp that was determined largely by the materials at hand.

The lamp house is four and one-half inches square and seven inches high. It was made by a tinner from scrap monel metal. Almost any other kind of sheet metal would do just as well, although a material that requires no painting is preferable. The bottom of the house is open and the top is equipped with a simple lid held in place by two nickeled bolts that engage slots in bent-over parts of the lid. Vent holes are drilled near the top, in the sides and rear only.

The tubular bulb is held in a heavy-duty aluminum-shell socket that is mounted in the approximate center of a square piece of sheet metal. This piece has the edges bent over for a distance of one-half inch and drilled to receive four bolts that pass through slots in the sides of the housing. The slots permit up and down adjustment, for centering the filament. The socket has a threaded shade holder that acts as a nut for holding it in the sheet-metal piece. The hole in this piece is somewhat larger than the socket, and washers are used to overlap it.

The condenser is a sixty millimeter short focus spherical lens designed specially for microscope work. It retails for about $2.50. It must be mounted in a tube that can be moved back and forth for focusing. The tube in the lamp illustrated is an old adjustable camera-lens mounting that happened to be available.

The lens flange was bolted over a hole cut in one side of the lamp house and centered approximately with respect to the filament.

THE base of the lamp is an eight inch sanding disk (with the sandpaper removed) of a type sold for home-workshop use. The short piece of steel shafting that extends up from the center of the disk is equipped with a ball-and-socket photographic tripod head that permits the lamp to be tilted as desired. In use, the bulb should be kept as nearly vertical as possible. The wires carrying current to the bulb are asbestos-covered fixture cord, doubled because of the heavy current; that is, ends of a two-wire cord are twisted together to form a single conductor, and two such cords are used.

If desired, a filter holder and water cell for absorbing heat can be attached to the lamp, at the outer end of the lens tube. The filters should be not less than two inches square. Special micro filters in gelatin form can be purchased and mounted between sheets of glass. (P.S.M. Nov. '33, p. 41.) The water cell consists of two parallel pieces of clear glass separated a short distance and mounted so that water can be held between them.

The bulb employed is known as the 108-watt, six-volt type, and can be obtained through most electrical dealers. It can be obtained with a single-coil vertical or horizontal filament or a ribbon-type filament. The vertical coil is the cheaper, and is satisfactory for practically all amateur work.

Plants *that* Feed Each Other

Strange Partnership of Fungi and Algae for Mutual Benefit

FOUND WITH YOUR MICROSCOPE

POPULAR SCIENCE MONTHLY
FEBRUARY, 1935

By MORTON C. WALLING

Only a part of the fungus structure of toadstools and mushrooms is visible above the ground. Underneath is an extensive rootlike network, the mycelium

Left, rootlike mycelium of a toadstool. Above, a plant partnership of alga cells and fungus strands

YOUR microscope will reveal to you one of the wonders of the Plant Kingdom—a strange partnership in which two plants have pooled their resources, with apparent advantage to both.

You are, no doubt, familiar in a general way with lichens, those formations that grow on the barks of trees, the sides of rocks, and fence rails. You may have noticed how frequently they are the first living things to appear on rocks in a quarry, on surfaces left exposed by the cutting away of stone. They flourish there, without soil and, to the casual observer, apparently without other means of obtaining food.

How can the lichen thrive on bare rock, where soil is lacking? The answer to this question can be revealed beautifully by your microscope. Go into the woods and find a gray-green lichen that is growing on a rock or tree trunk. Break it off and take it to your microscope laboratory. With scalpel or razor blade, cut sections from the piece. Lay some of these on a microscope slide, add a drop of water, and tear them into small particles with dissecting needles. Add a cover glass. Now look at the pieces through your microscope, at a magnification of at least 100 diameters.

You will see a tangled mass of white or colorless threads among which are scattered pieces of bright green material. Closer examination reveals that these green bits have a definite structure. They may form threads or masses of round or elongated cells, whose granules or disks of green chlorophyll will be revealed by higher magnification.

Here, then, is the answer to the question of how the lichen can live. The green bodies are cells of an alga, while the colorless strands are parts of a fungus. The alga may be of the same type as that you have seen growing as a green mass on the surface of a pond, or creeping over the outside of a flower pot. The fungus is a rela-

Spores produced by gill plate on a toadstool. The dark mass at the bottom of the print is the gill surface

tive of the mushrooms you had for dinner.

A fungus, lacking green chlorophyll which would enable it to manufacture life-giving starch from sunlight and air and water, must absorb its food ready-made. That is why molds and toad-stools always are found growing on decaying wood or other materials from which they can absorb ready-made food. The fungus part of the lichen has to get its food second-hand; but instead of selecting a mass of decaying leaves for its home, it has persuaded the chlorophyll-containing algae to join with it in setting up a novel kind of plant partnership.

The alga-fungus organization has worked out a production schedule so satisfactory that no labor troubles ever arise, so long as moisture and light and air are available. The alga manufactures starch for itself and the fungus, from air, sunlight, and water. The fungus, which has to depend entirely on the alga for its meals, does its share of the work by providing protection to the alga and by absorbing moisture from the air.

The lichen, therefore, is a partnership of green algae embedded in the grayish strands of a fungus plant. The brighter green of a wet lichen is caused by the fact that the protective layer of fungus strands is more nearly transparent when wet than when dry. The power of the fungus to absorb water from the surrounding air is amazing. It can live in places too dry for any other vegetation. Even after being kept in a dry state for years, some lichens are said to become completely revived in a short time, if placed in water or a moist atmosphere.

Above, a dead tree limb, on which a fungus is growing. In this case, the fungus gets its own nourishment from the decaying wood

For a better understanding of the lichen, you can make a microscopic exploration of fungi and algae. The fungi world is so extensive that no more than a few high spots can be considered here; and the algae must, for the time being, be left out entirely. However, you will not want for microscope material, for even a single mushroom or toadstool will provide hours of fascinating entertainment.

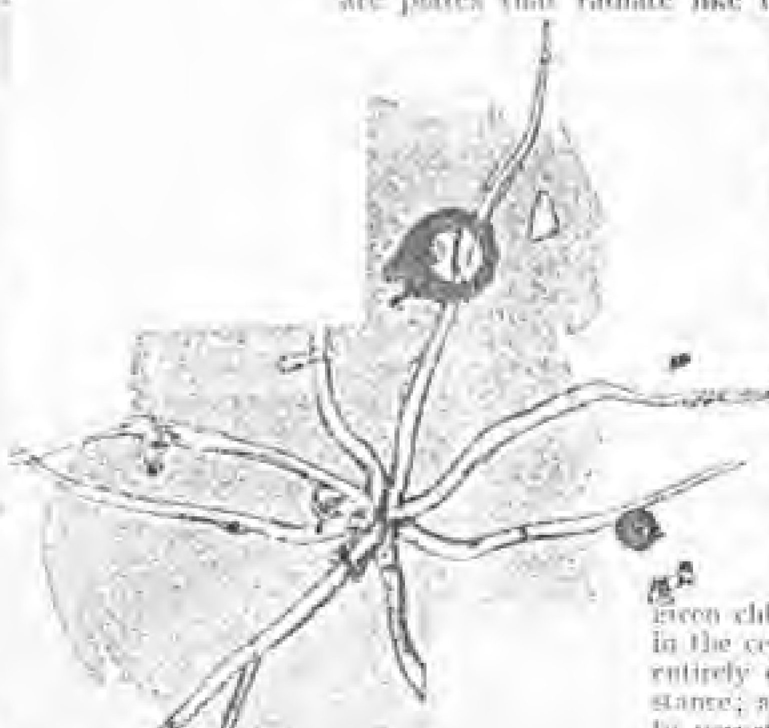
The common mushroom, that you have seen growing in fields and woods and on rotting logs, is a plant, but it differs so much from the general idea of plants that it is of extraordinary interest. More accurately speaking, the mushroom itself, the part of it with which the average person is familiar, is but a portion of a plant. It is the visible outcropping of a subterranean network, hidden in the soil or within the decaying mass.

This underground network, called the mycelium or spawn, is a system of cells whose function is to gather food from the medium in which it is growing. It grows usually in leaf-mold, decaying wood, and such places because of the great amount of ready made food to be found there. Under the microscope the mycelium looks somewhat like a root system, and is made up of colorless strands with hairlike threads or branches.

The mycelium of the common mushroom lives entirely underground, just beneath the surface. Careful examination of almost any particle of rich soil or rotting leaves will reveal it. Simply place the particle in a test tube or bottle of water and shake it vigorously, to wash away foreign matter. The mycelium fibers can be separated in a mass with tweezers. Perhaps an easier method is to find a mushroom, dig it up with a spoon so that part of the soil beneath it is obtained, and then wash the dirt away from the rootlike mycelium without bruising it.

The mycelium is a plant in itself, but because the local food supply may not last forever, it has to send out spores that will start new colonies of fungi in other localities. To do this, it produces fruiting bodies. These are the mushrooms you know. They spring up overnight at various points in the mycelium network. The process involves a sort of gathering of mycelium strands into knots which grow and merge into the stem and cap of a fruiting body that frequently is parasol-shaped.

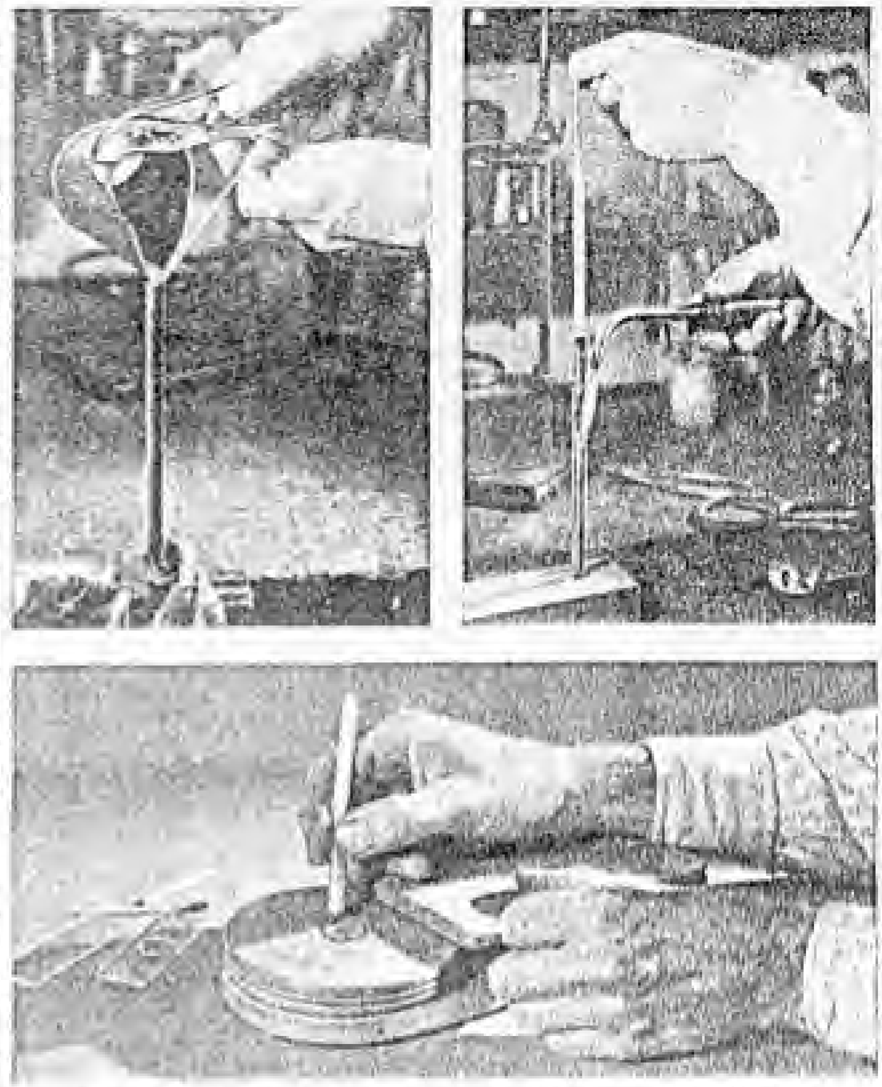
Examine a common mushroom. You will find that it has a stem surmounted by an umbrella-shaped cap. Around the stem is a ring of membranous tissue. Over the cap is a layer of similar tissue, which may extend as a ragged layer at the edges. The underside of the cap is lined with a system of gills, which are plates that radiate like the spokes of a wheel. The ring around the stem was formed during the growth of the mushroom by the breaking of the protective membrane that was stretched over the entire structure when it burst through the ground.



You will find it interesting to examine the entire structure of a mushroom with your microscope. With a sharp knife, cut thin slices from the stem and cap, and mount them in water on slides. You can employ various microscopic stains to bring out the structures of the cells. You will, however, fail to find any of the green chlorophyll that you have encountered in the cells of other plants, for the fungi are entirely devoid of this important plant substance; and for this reason, they are doomed to perpetual stealing of their food in ready-made form.

The gills are perhaps the most interesting part of any mushroom or related fungus. It is the gills that produce the all-important spores, which travel on the winds and in the bodies of animals to other places favorable for the starting of new colonies. Such places are not numerous, considering the earth's land

A tiny toadstool found in the field, or a mushroom from the grocery store, will provide hours of fascinating entertainment with a microscope.



The octopuslike object in the center of the page is a formation of mycelium strands in a lichen. The photographs above show successive steps in making paraffin cells for temporary slides. A thin candle is molded in a piece of pipe, which is removed by heating it gently and lifting the wick. The cell is spun by holding a hot candle end against the glass

area, so that each mushroom or other fruiting body must produce millions or even billions of them. It is to provide a great area in a compact space that the gill formation has been developed by the mushroom.

THE spores may be produced in a variety of ways. Among the most common is the system of club-shaped basidia that cover the surfaces of the gill plates, like masses of tenpins standing with their sides touching. The basidia of the common mushroom usually produce two to four nearly spherical spores each, the spores growing from little tips that project from the tops of the club-shaped structures. The spores ripen, fall off, and are caught by the wind and carried away. Another common method of producing spores makes use of long, tubular pods, or asci, in which the spores grow like rows of beans or peas. When the spores are ripe, the pods burst and liberate them. These different methods of spore production have given rise to the names Basidiomycetes and Ascomycetes respectively. Several other methods of bearing spores are known.

With your microscope, you can see the spore-bearing basidia or other organs. Remove some gill plates from a mushroom, and tear them into small pieces in a drop of water on a slide. Lay a cover glass over the drop, and examine carefully at 200 diameters or so. Here and there you will find a piece of gill tissue that is arranged so that you can see the rows of basidia massed compactly on its surface. If the specimen has reached the spore-releasing stage, you can observe the countless numbers of spores that have been given off. To collect the spores alone, lay the cap from a mushroom on a piece of glass or paper, and place under a bell jar. The spores will collect on the support in a pattern determined by the arrangement of gills.

A LICHEN generally is a union of an alga and a member of the Ascomycetes. Sometimes, when examining a lichen under the microscope, you can see the tiny spore-pods or asci. Incidentally, only the fungus part of the lichen seems to have the power of reproduction.

Although the fungus spore serves the same purpose as the seeds of higher plants, it differs greatly from them. A seed contains a tiny embryo plant, while a spore is simply a cell that possesses the power to grow into a plant. When a mushroom spore, for instance, alights on a moist layer of rich soil where growing conditions are right, it develops into a tiny speck of mycelium. This grows and penetrates the surrounding soil. Its job is to absorb food from the soil, to expand and to produce the fruiting bodies or mushrooms. When mushrooms are grown commercially, the beds become interwoven with the mycelium threads. The bed material is compressed into bricks and sent to other growers who, by planting bits of the brick, can start new beds.

Your fascinating examination of fungi need not end with an investigation of the common mushroom. There are hundreds of other kinds of fungi or molds,

which you can find almost anywhere. A photographer once experienced considerable trouble because a tank in which he rinsed films and plates became filled with masses of threadlike material. Examination showed that the material was a fungus plant, thriving on the gelatin that dissolved out of the film and plate coatings. This fungus proved to be a beautiful object under the microscope.

Fungi studies can be carried on at any time of the year. In winter, mushrooms can be purchased from stores. A trip into the woods will provide bits of decayed wood that will produce abundant crops of fungi when placed in a warm, moist place; and lichens that can be stirred to life by similar treatment.

THE problem of making temporary slides of fairly thick sections can be solved by a method developed in one of the government microscopic laboratories. This method consists of spinning a paraffin ring on a glass slide, to make a shallow cell. Paraffin can be used when the mounting medium is water or some substance that does not dissolve it.

Materials required include a spinning wheel, whose construction already has been described in this series, and a slender wax candle. You will have to make such candles yourself, for it is difficult to purchase them.

To make a candle, obtain a piece of brass pipe about one-fourth-inch inside diameter and six inches long. Plug one end with a piece of wood or a cork. In the center of this cork, on the end that is in the pipe, fasten loosely a pin or small nail, and tie to it one end of the heavy cord that is to serve as a wick. The nail or pin must be so loose that it will pull out of the cork when the latter is re-

moved. With the wick running up through the tube, fasten the latter in an upright position, with the corked end downward, and pour melted paraffin into it. When the paraffin is on the point of becoming solid, adjust the wick so that it will be centered.

WHEN the wax has cooled, remove the cork from the lower end, and hold the wick in one hand so that the mold dangles below. With a gas or blowtorch flame, gently warm the mold evenly over its surface, until it drops off under its own weight. When carefully done, only a thin layer of wax will be lost. Straighten the candle while it is still pliable, and lay on a flat surface to cool.

To spin a paraffin ring, place a slide on the wheel of the spinning machine, light the candle, let it burn for ten or fifteen seconds, blow out the flame and immediately touch the wick to the slide, which has been set spinning. The molten wax of the wick will flow out on the glass and cool instantly, forming a ring that can be built up to any practical thickness. Cells thus formed have remained intact for years.

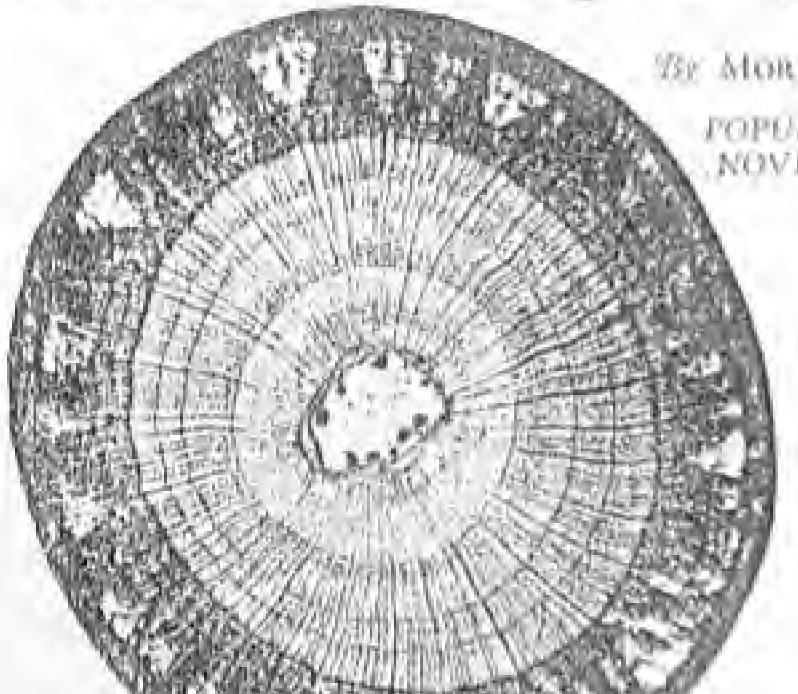
The inexperienced microscopist frequently has difficulty with air bubbles. He discovers what he thinks to be a new kind of cell or animal, only to learn in the end that it is a tiny air bubble that is drifting across the field of view. Sometimes these bubbles, acting as tiny lenses, produce beautiful effects. One of the first things instructors of classes in microscopy teach their students is to recognize an air bubble. It is a good idea for every beginner in microscopy to follow this rule, and study bubbles before turning his magic lenses on anything else. Production of air bubbles is easy, frequently exasperatingly easy. Simply drop a cover glass carelessly on a drop of water placed on a slide, and you generally will imprison at least one bubble. Water from a half-filled flask that has been shaken vigorously may provide an abundance of tiny bubbles, when a drop of it is placed immediately on a slide and cover glass added.

Microscopic Marvels YOU CAN FIND IN YOUR GARDEN

Stems of Common Plants Afford An Almost Unlimited Field for Amateur Study and Observation

By MORTON C. WALLING

POPULAR SCIENCE MONTHLY NOVEMBER, 1935



A stained section of a basswood stem, magnified fifteen times. The pith center is surrounded by rings of woody cells and beyond these are the vascular bundles.

This work table for the microscopist, described on the opposite page, has sunken compartments for bottles and other paraphernalia. At left, slicing a tulip stem with a razor on a cork pad

POSSIBLY you are all set for a microscope journey but have no place to go. At least, so you think. But if you have a botany textbook, it will offer suggestions for many interesting trips.

Even if you concentrate on only one small but important part of the plant structure, you will find no end of material. Suppose, for instance, that you decide to investigate stems—to look at all kinds of stems, and to slice up in various ways and examine every stem you can get your hands on.

Sounds simple, doesn't it? The work of an hour or two, you think. But in truth it would take you weeks, months, even years to learn all there is to be known about stems. A piece of lumber is nothing but part of the stem of a tree. And there are scientists who do nothing but study wood!

A stem's main job in life is to support the leaves. It also carries water and food, and assists in other minor ways. Botanists classify stems as herbaceous and woody. The first kind is much like a leaf in construction. If you slice a herbaceous stem, such as that of a clover plant, crosswise into very thin sections and examine one of them with your microscope, you will see that the stem has a distinct structure.

There is, encircling it, a thin layer called the epidermis. This is composed of transparent cells. Directly below it is the pale green chlorenchyma which, by its color, suggests that it helps aid the leaves in the manufacture of food for the plant. Next, in order, are the veins, known by a variety

of aliases such as fibrovascular bundles, vascular bundles, or just plain bundles. Usually these veins are grouped into a ring, encircling the center section of the stem. Under the microscope the veins, water pipes of the plants, are usually very distinct. Their job is to carry water through the stem. In the center, enclosed by the ring of veins, is the pith, a sort of food-storage reservoir for the plant.

In older parts of stems, there can be seen further refinements in the stem structure. Extending through the bundles of cells making up the veins, and uniting them into a sheath, or ring as it appears under the microscope, is the cambium layer, the seat of growth in the stem. It is this layer that, by cell multiplication, grows and produces new material both inside and out.

Then there is, directly beneath the almost transparent epidermis, a white band of tissue that glistens when the illumination is right. This is the collenchyma, a reinforcing sheath whose function is much the same as that of the wire or iron-rod reinforcements in a concrete pole. Engineers have copied this collenchyma in the building of airplane frames with steel tubing that is light in weight yet strongly resistant to lateral strains.

Tear almost any soft stem into shreds and examine the particles under the microscope. Among the masses of tissue you will see long tubes resembling tightly coiled springs. These are the ducts or tracheids which help make up the fibrovascular bundles. Other large tubes resembling cylindrical sieves may be seen. These tubelike cells run to all parts of the plant, from root tip to branch tip, carrying water and food. The balsam and some other plants produce stems transparent enough for you to see the water-carrying cells without making sections or tearing the

Build This Handy Microscope Work Table

AT A recent hobby show held in New York, a young man watched—fascinated—while an amateur microscopist showed how a fly's eye could be removed and mounted on a slide in something less than two minutes.

"You know," the young man said, leaning forward eagerly, "I've read a lot about microscopes but I never got one because I haven't any place to work."

"You can borrow the kitchen table for part of the evening, can't you?" the amateur microscopist asked.

"Sure. But you've got to have a whole room to ride that hobby."

"That's where you're wrong," the amateur smiled. "One of the best things about microscopy as a hobby is that it is convenient. You can practice it almost any place—in the kitchen, parlor, bedroom, or basement."

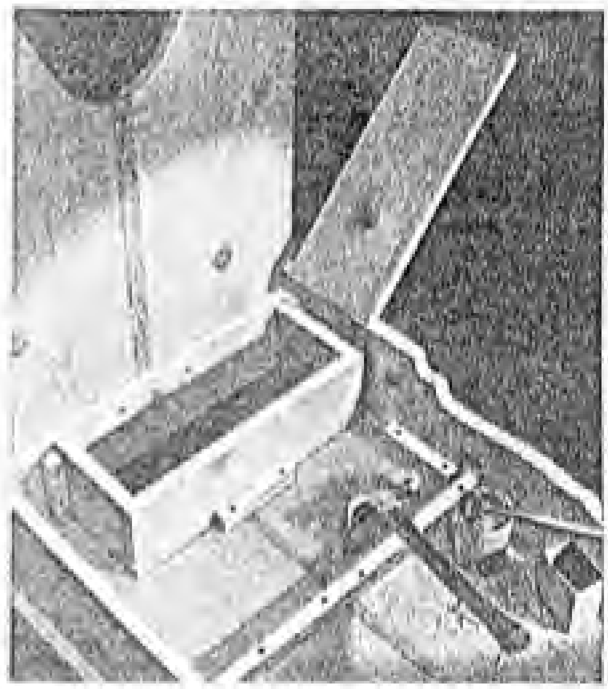
The amateur was right. You can discover much of the invisible world that only the microscope owner knows, if you can find a two-foot-square space on which to work. However, it cannot be denied that a permanent place to pursue your hobby, such as a table or perhaps even a small room set aside for a microscope laboratory, is a highly desirable convenience.

Almost anyone can find space for a modest-sized table that will house the accouterments of his hobby. The making of a table like that shown in the picture at the top of the opposite page, is not difficult. It does not require elaborate machinery. Cost is a matter of two or three dollars for materials.

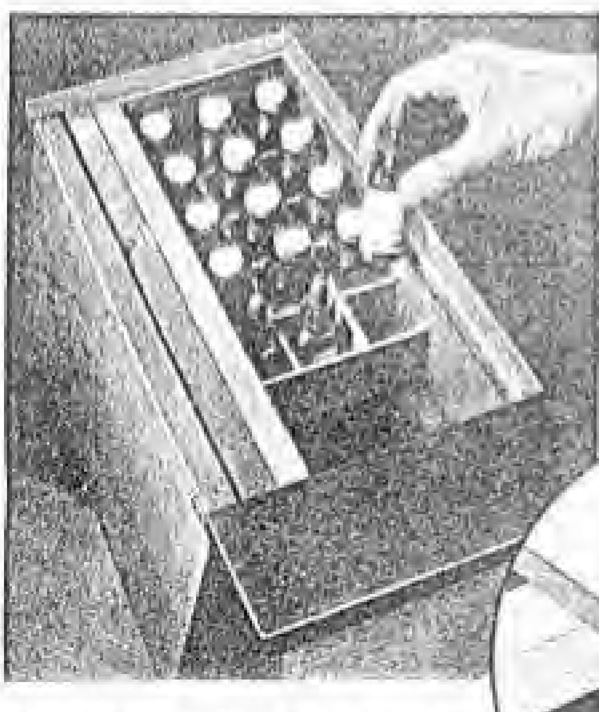
Almost any wood can be used; redwood, pine, and cypress being among the cheapest and easiest to work. Use one-inch stock, sanded on one or both sides. The table, whose construction and dimensions can be determined from the diagrams, is similar to any ordinary table except that it has a comfortable footrest and two wells, one at each end, covered by hinged lids, for the storage of reagent bottles, specimens, and equipment.

The lids are hinged to swing upward and outward when they are grasped at their outer edges with a turning motion. The table shown was made of knotty white pine, and stained to harmonize with other furniture. Its top was painted with a chemical-resistant paint, although ordinary floor or deck paint will be a sufficient covering.

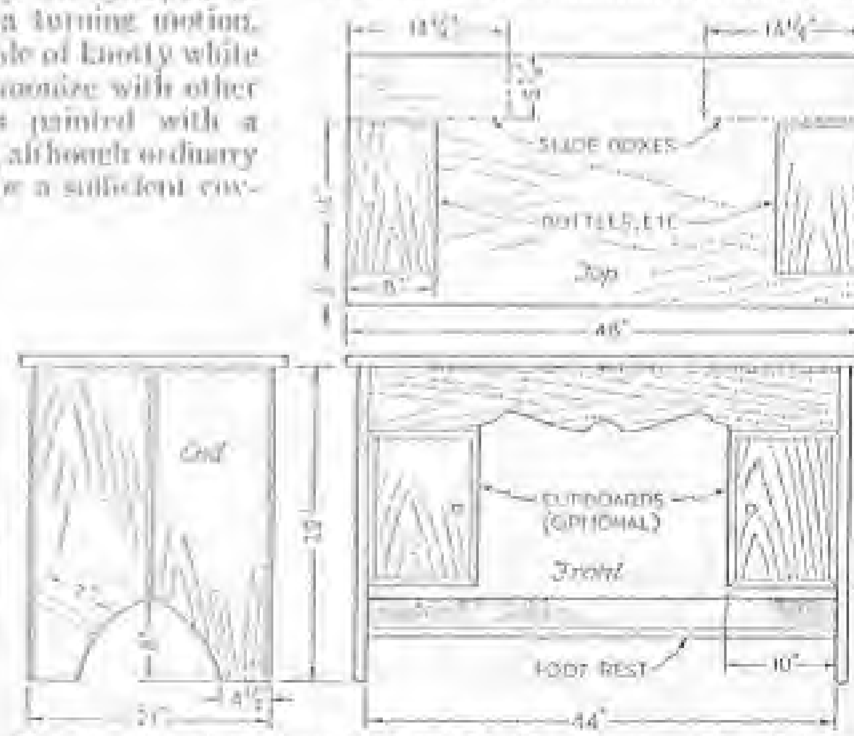
made to the table in the form of boxes mounted on the top or directly behind the hinged lids for holding slides and the like. Cupboards or drawers may be installed inside the end pieces as needed.



Details of underside construction, showing one of the sunken compartments for storing bottles



Sunken compartment of the microscope work table, with the lid turned back on its pivot hinges. The bottle rack is made of light wood. The picture at right shows how a butt hinge is rearranged into a pivot



This drawing gives dimensions and details of construction of the work table described above. Cupboards and drawers can be added if desired

stems apart.

Stems of the clover, geranium, soft tips of tree branches, and almost all other herbaceous stems show, in cross section, a ring-shaped arrangement of the veins. However, the corn plant is different. Cut thin slices from a young corn stalk and examine them. You will find that, at fifteen or so diameters, the specimen reminds you of a lace doily. Among the thin, almost colorless pith cells are arranged, in a more or less evenly spaced fashion, the fibrovascular bundles.

Woody stems are grown-up herbaceous stems. By studying such stems with your microscope, you can learn why leaves fall in the autumn. If you slice a twig lengthwise at a point where a leaf is growing, you can see that the veins branch out from the twig and follow the leaf stem.

In the late summer or fall, a layer of tissue grows across the base of the leaf, gradually closing off the water and food supply. The leaf, deprived of water and food, begins to wither. The chlorophyll quits work and the leaf changes color. Finally it falls, dead, to the ground. The abscission layer of tissue that grew across the base of the leaf becomes a corklike seal for the scar left on the twig stem.

Examine a winter twig at low magnification and you will see that it is covered with tiny wartlike projections. These are the lenticels. When the leaf dies and drops off, its stomata, or breathing pores, naturally can no longer serve. But the tree must continue breathing through the winter. So, over the surface of the winter twig, the usual epidermis is replaced by a waterproof layer of corklike material, which is pierced with many lenticels. These lenticels serve as breathing pores in place of the stomata of the leaves. Respiration is vital to the living tissues inside the twig.

If you cut a cross section from one of these transitional stems or winter twigs, you will see that medullary rays, fine radiating lines formed by layers of tissue between the fibrovascular bundles, are present. It is easy to distinguish between the bark and the woody growth inside the cambium layer.

The center of the section contains the delicate pith cells. Drop a weak solution of iodine on a cross section of such a stem (winter twig) and a blue color will appear in various parts, indicating the presence of starch. The pith, particularly, is used as a reservoir for the storage of starch as winter food. The iodine test also will show starch in the bark and medullary rays. The colored pattern formed by the test frequently is very beautiful under the microscope.

As THE stem grows older, the chlorenchyma or former green part of the stem loses its chlorophyll and becomes a part of the bark. The epidermis and collenchyma have changed into a waterproof sheath of cork. Inside the cambium is the xylem, containing the ducts for carrying water, while outside is the phloem, with the perforated sieve tubes.

As the stem matures still further, the cambium produces new wood inside and new bark outside. The wood increases in quantity while the bark, by weathering and peeling, remains fairly constant in thickness.

The alternate rapid growth of cells in the summer and the complete or virtual cessation of growth in winter causes the appearance of annual rings—bands or sheaths of woody cells which are large towards the center and small towards the outside. By counting the annual rings, the age of the stem can be determined.

While stem sections in their natural state are beautiful objects for the microscope, their beauty can be increased greatly by the application of stains. Such stains, because of their selective action, will also bring out the various cell groups more plainly. Iodine, mercurochrome, eosin, methylene blue, and haematoxylin are but a few of the staining materials you can employ. It is fun to experiment with various combinations.

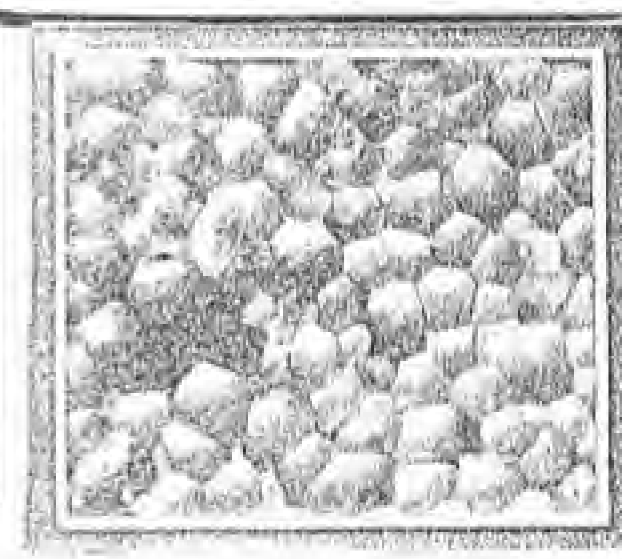
You will discover, before you have succeeded in slicing many plant stems with a razor blade and a piece of cork or wood as a cutting block, that soft stems have a habit of crushing or that the cell formation is disturbed by the pressure of the blade. Often a satisfactory job of making either cross or longitudinal sections can be done with the aid of elder pith.

Simply split a piece of pith in two, cut a groove to receive the stem, then put the halves together again so that they will brace the stem as it is being cut. You can buy dry pith or get it from elder stocks. You might try freezing the stem, if it is very soft, in a mechanical refrigerator or by immersing it in a mixture of cracked ice and salt. Do not freeze it too solidly.

LABORATORY methods of making stem sections call for dehydrating in alcohol, clearing in xylol, infiltrating with and embedding in paraffin, and slicing with a microtome. The slices are cemented to slides, and paraffin dissolved away, the specimens stained, dried, and mounted in balsam.

If you want to make permanent slides of some of your stem sections, stain them, pass them successively through two or three glycerin baths of different degrees of dilution with water, and finally through pure glycerin, which is used as the mounting medium. Seal the edges of the cover glass with gold size. This method, while not as permanent as the use of Canada balsam, does away with the somewhat involved system of dehydration with alcohol.

The beauty of plant stems under the microscope is greatly increased by the application of a stain, as illustrated above



Wonders of the SEA Through Your Microscope

How Marine Specimens, Easily Obtainable, Are Prepared for Examination—Making Your Own Bell Jar at Slight Cost

BY MORTON C. WALLING

SHELL'S HIDDEN MOSAIC

At right, a bivalve as it appears when pictured by the [illegible]. When a thin slice of this shell is put under the lens of a microscope that magnifies it 150 times, it is seen as the beautiful mosaic pattern that is illustrated in the square at upper right

NO MATTER where you live, many of the wonders of the sea can be brought beneath the lens of your microscope. A visit to the seashore is unnecessary. You need only make a selection of things you will find either in your own home or at the neighborhood drug store.

For instance, the drug store, probably, will be able to supply you with cuttlefish bone, originally intended for the pet canary. There also you can get cheap little yellow sponges and shells fashioned into novelties. Almost every home has bits of coral brought from Bermuda or Florida. These articles are enough with which to start your fascinating exploration of the marvels of the great sea.

Take first the cuttlefish bone. Examine it carefully, and you will find that it is made up of a thin, hard shell shaped like the bowl of a spoon. The hollow side is filled with a soft, chalklike material that canary birds like to pick. This material is lime that was deposited by the cuttlefish.

If you are acquainted with the cuttlefish, you will know that this bone really is a shell found directly beneath the skin of the animal's back.

With a sharp knife cut a piece from the soft portion of the shell, and carefully trim it to form a cube. With your unaided eye you can see that, on one face, the material is made up of nearly parallel lines or plates resembling somewhat the end grain of wood. Trim this face of the cube so that it runs squarely across these lines. Then trim an adjacent face parallel to one of the plates. Lay the piece on a glass slide, with the lined surface uppermost; and arrange the illuminator so that a beam of light is directed on the top surface, striking it at a fairly sharp angle. Look into your microscope.

Did you ever see a commonplace object become suddenly more beautiful?

The cuttlefish bone, at fifty diameters, is revealed as a crystalline palace containing a succession of fairy caverns. It looks, indeed, like a cross section of a many-storied glass building. You can see floor upon floor running across the field of vision in slightly curved lines. But instead of orderly rows of individual columns supporting the successive floors, you see an apparently confused arrangement of what appear to be thin partitions, broad pillars, and several icicle-like projections extending part way up or down.

After studying this surface of the cuttlebone cube you still may be in doubt as to the exact way in which the builder of this remarkable structure provided for the support of the successive floors. Turn the specimen over until the next surface, the one cut at right angles to the first, is in view. If you have trimmed the piece properly, you can see how the supporting members are arranged.

It is as if you were directly above a building from which the roof and part of the top story had been removed. The layers of the cuttlefish bone, you find, are separated and supported by thin ribbons of lime, winding in and out among each other. If the builder of that bone had been working with steel instead of limestone, he would have supported the floors by means of thin sheet-metal plates bent in and out, like irregularly corrugated iron, to give them great strength.

But why all this complicated structure, instead of a simple deposit of limestone?

Reflect a moment, and you will realize that such material is, like corrugated metal or other material, light in weight and at the same time mechanically strong. Throw the bone into water and it will float, thanks to the thousands of tiny air cells in it.

Your microscope has proved to you that the cuttlefish bone, or, more accurately, shell, serves the double purpose of stiffening the animal's body and acting as a float. You will have to admit that, with such heavy material as lime, the builder of this float has succeeded remarkably well.

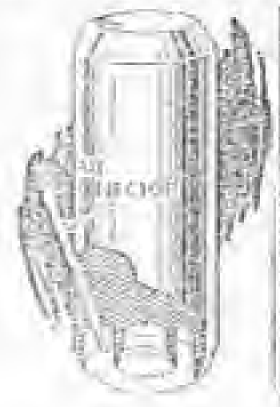
The little yellow sponge you purchased is not a whole sponge at all, but only the skeleton of a water animal known to zoologists as a member of the Phylum Porifera—meaning, in everyday language, a classification of animals that have characteristic pores or holes in their make-up.

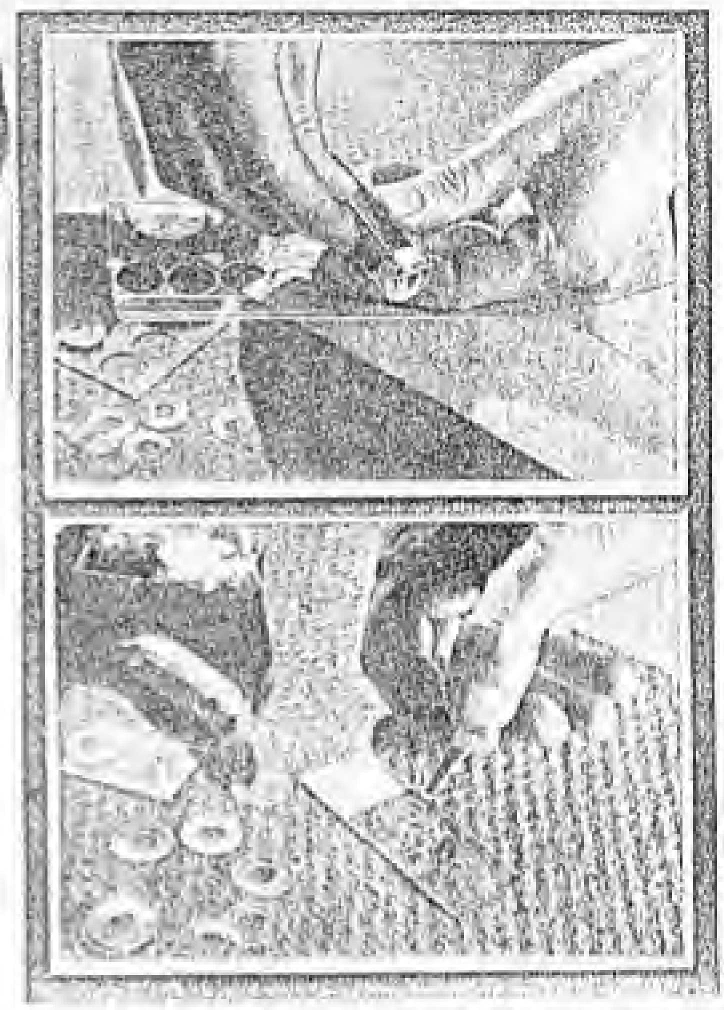
With a sharp knife or shears clip a small, thin slice from the sponge. You may be surprised at the toughness of the material. Lay the slice on a glass microscope slide and drop over it a clean cover glass to prevent it from being blown away. Use a low power at first, and focus on the fragment.

What you see is a three-dimensional network of horny fibers. There are few branches with free ends, except at the cut edges of the piece. The whole maze looks like something made by a miniature builder who amused himself by joining together rods of various lengths, without apparent rhyme or reason.

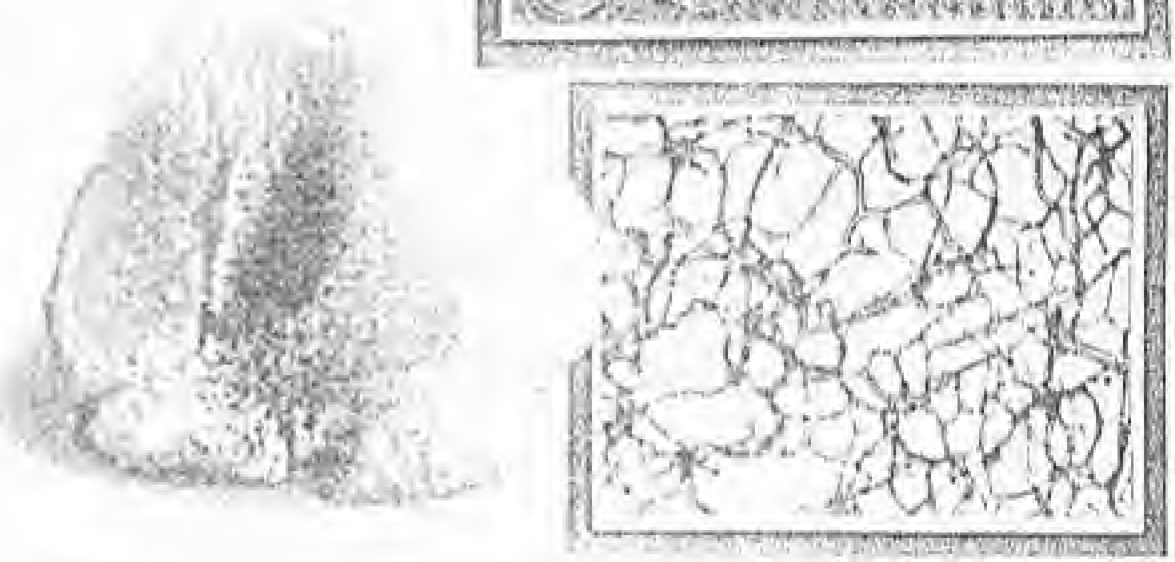
This horny maze, the skeleton of a sponge that once lived in the sea, is composed of a substance that is chemically related to silk. The scientific name of this material is spongin. It was secreted by special cells in the living sponge.

The network structure of the typical bath sponge is but one of the forms found among sponge skeletons. If you have, for example, a finger sponge, put a slice of it under your microscope. You will find it is made up of a horny network like the bath sponge, but that the structure is not nearly so clean-cut. There are numerous irregular projections or





At upper right, a homemade punch invented to cut washers from celluloid. These help in making slide cells. At right, one of the washers is being placed on a slide that has been smeared with balsam. Above, nail ejects washers



PROBING A SPONGE'S SECRETS. At left, above, an ordinary bath sponge. At right, a piece of its skeleton under a microscope that magnifies it thirty-five times

MAKING YOUR OWN BELL JAR

branches intermingled with the pointed spicules?

Other sponges—which you probably will not find in stores—have skeletons composed of needlelike bodies of silicon, or carbonate of lime. Under the microscope, they appear like simple needles or pins, like needles equipped with cross arms, or like pointed jacks with which you might play a game. These separate fragments adhere together with surprising tenacity.

Now that you have acquired an acquaintance with sponges by examining their skeletons, turn again to shells, this time to one of the bivalves with its mother-of-pearl lining. The shell of the pearl oyster, the mussel, and various shells picked up along the sea shore afford excellent material.

Select a piece of shell from near the edge beyond the mother-of-pearl lining. Usually you can find portions that will transmit enough light to permit the use of the substage mirror. Focus on one of these thin places, using fifty to 100 diameters magnification.

In an instant, your conception of sea shells will change. The first glance reveals a beauty the existence of which you never dreamed. Your first thought, probably, will be of a beautiful mosaic tile floor, perhaps one that is enlivened with color. The sight that greets your eyes is an expanse of tiny blocks or prisms, perfectly fitted together. Some of the blocks are large, some are tiny; but in general they are fairly uniform in size. They differ, too, in shape, but you will find that most of them have six sides. Often in the same shell you will see masses of blue, yellow, brown, black, and clear prisms. Sometimes there is a rainbow color effect that is indescribably beautiful.

The shell layer that exhibits this formation is made up entirely of little prisms joined together side by side. Their ends form the two respective surfaces of the layer. This

At left, how the bottom can be cut from a one-gallon glass bottle, the mouth of which is then securely corked. With the cut edge bound with tape, it becomes the bell jar for a microscope as is seen above

prismatic layer is composed largely of carbonate of lime, the same material found in the skeletons of some sponges and in cuttlefish bone.

AN INTERESTING little experiment indicates that lime is not the sole substance used in constructing the prisms. Select a piece of shell that plainly exhibits the prismatic structure, and place it in a drop of dilute hydrochloric, nitric, or sulphuric acid. It will bubble violently, indicating that the lime carbonate is reacting to produce carbon dioxide gas. When the bubbling has ceased, remove the piece of shell and you will find it has lost its stiffness. If you now place the shell on a glass slide and slip it under the microscope, you will see the same mosaic formation, though perhaps changed as to color and general appearance. Now very carefully introduce a sharp-pointed needle into the field of view and press the edges of the prisms of the shell against the glass slide. The prisms, formerly so resistant to breaking, now crush easily into a shapeless mass.

Apparently the layer of prisms, the individual prisms even, are protected by a thin film of horn-like material. Zoologists say that the horny outer layer, found on the surface of mussel and similar shells, protects the lime-containing layers beneath from carbonic acid in the water, and also imparts to the shell much of its color.

Would you like to know the secret of the pearl's popularity? Your microscope can tell you.

Turn to the inner pearly layer of the shell and examine it with your unaided eye. The surface reflects light in prismatic colors of great delicacy, and it has a luster that is found in almost no other substance.

PLACE the shell under your microscope and, at say 100 diameters, you will see the reason for much of this beauty. You will find that the surface is marked with many fine, wavy lines that run almost parallel to each other. There seem to be alternate ridges and furrows. The distinctness with which you see the lines depends on the manner in which you illuminate the shell. Some specimens are thin enough to be examined by transmitted light; but usually you will have to employ reflected light. If there is too much illumination, you will see only a glaring circle of white. Often the introduction of a color filter into the light beam will bring out the detail.

There seems to be some difference in opinion as to the exact nature of the pearly structure. Some investigators suggest that the furrows and ridges that mark the surface are outcroppings of layers of thin plates, or laminae. Others say that the lines are caused by folds or plaits in a single membraneous layer, the folds being at an angle to the surface. The interference of light rays reflected from the edges of the folds and from the furrows between them.

The pearly luster results apparently from the action of light that is reflected by the various transparent layers, together with that reflected from the surface. A spherical pearl, the kind prized as a jewel, likewise is composed of thin layers which reflect light in a similar manner. The thinner the layers, the better the luster. That is the reason why salt-water pearls, which have thinner folds, are superior to fresh-water pearls.

YOU will discover many other things about sea life by making microscopic examinations of commonplace objects such as those already mentioned. If you live near the ocean, or ever get the chance to make a seashore visit, you are prepared, with this meager introduction, to embark on a trip of microscopic exploration that will rival in excitement and interest the most unusual experiences of surface-going explorers.

During such a seashore visit, you will be wise to collect material with which to make permanent microscope slides. In fact, one of the most fascinating phases of amateur microscopy is the creation of a slide library. If you find, for example, a piece of sea shell that exhibits the mosaic-like structure unusually well, you ought to mount it permanently for future examination and exhibition to friends. Simply clean it well, dry it, and mount it in a balsam-filled cell.

If you follow the established method of making a cell for mounting thick specimens like the piece of shell, you will spin a shellac ring on the surface of the slide; then you will fill it with balsam, introduce the object and finally apply a circular cover glass. The chances are that, out of a dozen shellac rings, not more than half will be perfect—unless you are blessed with considerable skill or long practice.

There is a method, however, of constructing perfect cells in a minimum of time. The process consists of placing beneath the cover glass a washer whose thickness is sufficient to provide space for the specimen. The washer may be made of some transparent material such as celluloid, or of an opaque substance like thin paper. The outside diameter of the washer is the same as that of the cover glass. In mounting specimens, simply

smear a little balsam on the slide, place the washer on it, apply more balsam to the cavity and upper surface of the washer, introduce the specimen, and drop the cover glass into place.

MAKING the washers is not difficult if you have a suitable punch. If you have access to a metal-working lathe, you can construct one in a short time. Otherwise, you can have a machine shop make one for a few cents. The punch consists of a steel rod having one end turned so that two circular cutting edges, concentric circles, are formed. The outer circle is of the same diameter as the cover glass. The inner one should be about one-fourth inch smaller in diameter, producing a washer having a section one-eighth inch wide. For very small specimens, the central hole can be smaller.

Cutting edges of the punch should be as sharp as possible. There is no need to harden the tool, as it seems to stand up well without special treatment. Use drill rod or tool steel for the material. After the lathe work is finished, drill a small hole so that it runs at an angle from a point between the two cutting edges to a point in the side of the tool an inch or so from the end. Into this introduce a rod with a rounded point. This arrangement is necessary in order to remove the discs that frequently become wedged tightly between the cutters. An alternate method is to fill the cavity between the cutting edges with resilient rubber which expands after the hammer blow and expels the washer.

OLD photographic film from which the emulsion has been removed by soaking in a hydrochloric-acid solution, sheet celluloid such as that sold for automobile curtains, heavy paper, and similar materials can be used for the washers. You can cut a hundred of them in a short time. Use, if possible, stock of several thicknesses for different sized specimens. In cutting, simply place the stock on a block of hardwood, set the punch on it, and strike the head with a hammer.

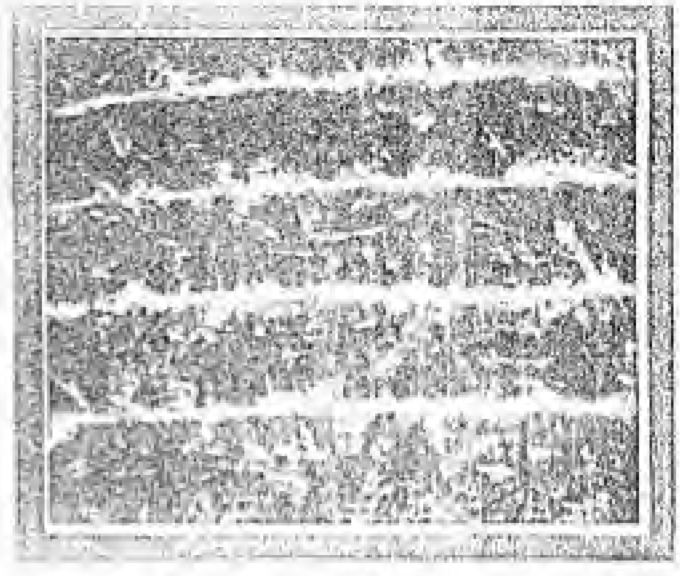
You will find that the use of these cuttings will give a professional appearance to your work. You can add a finishing border of asphalt varnish if you wish, or you can cut similar washers, slightly larger than the cover glass, from colored, gummed paper, and paste them over the cover-glass edges after the balsam has set thoroughly.

The washer system can be used for square cells as well as round, if you make a punch for cutting square washers. Usually, however, the circular form is preferable.

Microscopic view of section of pearl from a sea shell, showing the tiny ridges that are believed to cause the iridescent appearance

Unless you live in some kind of Utopia, you will find that dust quickly collects on your microscope and other equipment if it is standing in the open for a time. One of the most dangerous enemies of a microscope is the grit and fine dust settling on it from the air. In well-equipped laboratories, glass bell jars are employed for covering instruments when not in use.

A BELL jar, you will discover if you set out to purchase one, costs money. However, there is a way in which you can make a serviceable one at a trifling cost.



CUTTLEFISH BONE SPECIMEN. At left is illustrated the method of cutting a piece of cuttlefish bone into a small cube for microscopic examination. Above, the specimen as it appears when magnified about fifty times

From a drug store obtain a glass jug or bottle. For most amateur microscopes, a one-gallon size is sufficient. Select one that is made of clear, uncolored glass. The next task is to remove the bottom. This is accomplished most surely and easily as follows:

Clamp an efficient glass cutter to a block of steel or wood and adjust it so that the cutting wheel will touch the glass jug at a point three-fourths to one inch from the surface on which both the jug and block are resting. Rotate the jar, pressing it against the cutter wheel so that a line is scribed in the glass. You will be wise to wear gloves during this and subsequent operations.

After the cut has been completed, introduce into the jar a hammer made by bending a one-fourth-inch rod of iron at right angles an inch or so from the end. Tap the glass lightly opposite the cut, continuing around the jar until the line has broken completely through. The bottom will drop off cleanly.

With a file wet with turpentine in which some camphor has been dissolved, you can remove the sharp glass edges as easily as if they were made of brass. Finally bind the cut edge with one or two layers of adhesive tape, insert a cork into the opening at the top, and your bell jar is complete. The taped edge, besides being more attractive than the somewhat ragged glass, is dust-proof and prevents damage to the microscope if the jar accidently strikes it.

Dancing Dragons

SEEN WITH YOUR MICROSCOPE

By Morton C. Walling

POPULAR SCIENCE MONTHLY AUGUST, 1936

NO MATTER where you explore with your microscope, you may find nematodes, dragonlike worms which are engaged constantly in a writhing dance, and whose numbers are believed to be greater than the insect population.

Amazing are the variety and distribution of these important but, to the average person, almost unknown creatures. Many kinds, known variously as threadworms and roundworms, live in fresh water. Other thousands of species are found in the soil and in the sea. There seem to be few

The deadly trichina worm, which causes trichinosis by embedding itself in animal muscle

animals, from the tiniest insect to the biggest quadruped, in which they are not found as parasites. Some nematodes even have smaller nematodes living inside their bodies!

With such abundance, it ought not to be difficult for the amateur microscopist to discover enough of these minute worms to keep him busy for a long time. He can find them in almost every sample of mud, sand, aquatic vegetation, or decaying plant material from ponds, lakes, streams or seas in any part of the world. He even can find them in the family vinegar jug.

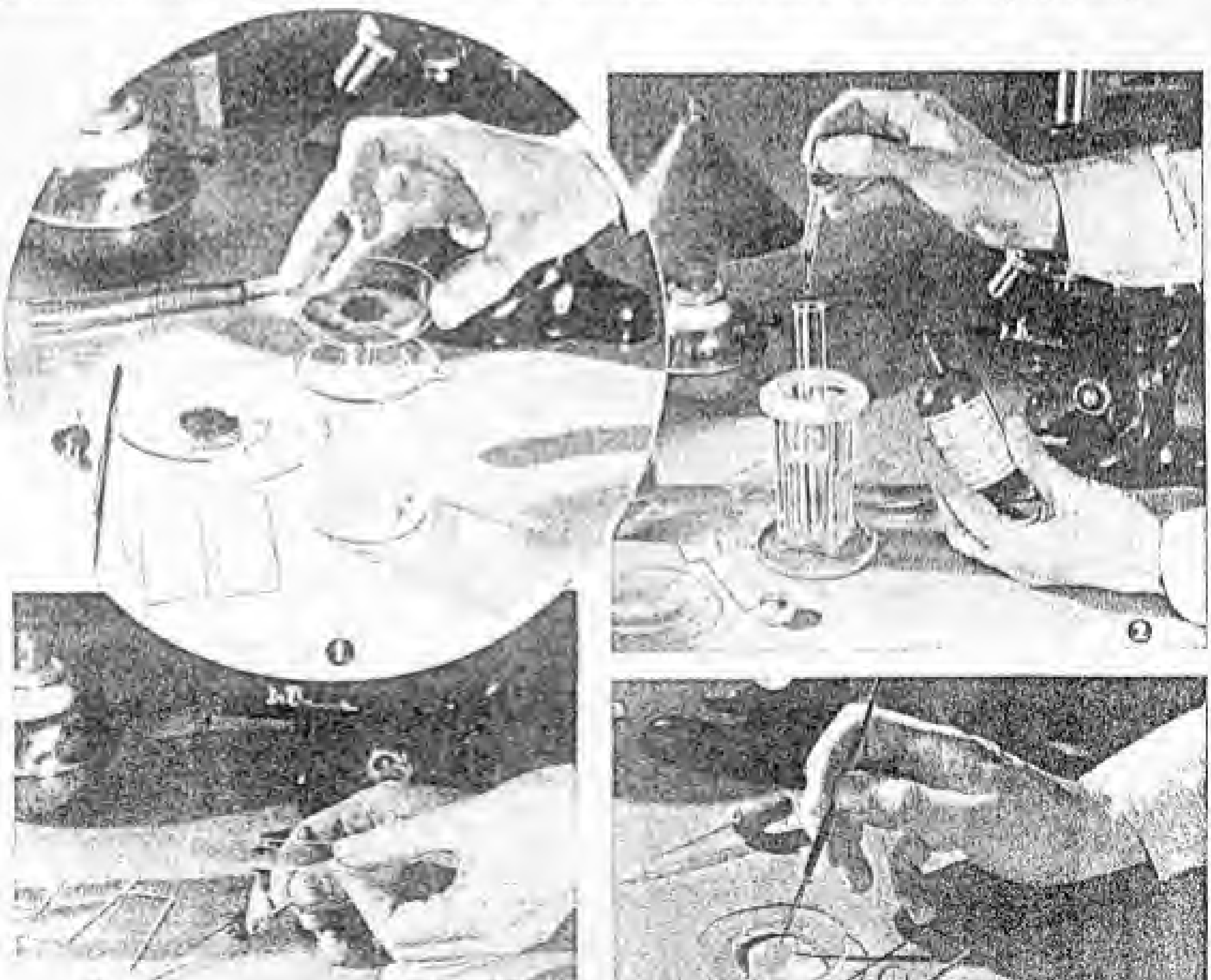
The vinegar eel or vinegar worm is perhaps one of the best-known nemas. It is visible to the naked eye as a wiggling, whitish line in most vinegar that contains a distinct sediment. Put a drop of vinegar thus inhabited on a slide, and lay a cover glass over it. Examine the eels with a low power, say twenty-five to 100 diameters. You will discover that the worms do not remain still for even an instant. They whip about constantly in the film of liquid between the two pieces of glass.

The vinegar eel, although an easy nematode to find, is not very important when compared with others of its kind. Neither is it very ferocious-looking. Some of these tiny worms which greet the microscopist as he peers down his tube would make the mythical oriental dragon spit envious fire. Three horrible jaws which open and shut like the jaws of a lathe chuck, and which may be studded with tiny teeth; curved spines projecting out from the head in a startling manner; a body armored with ringed structures—these are a few of the dragonlike characteristics found in some nemas.

Nematodes living in fresh water and in the soil make excellent microscopic specimens because they require almost no preparation. Their bodies are so transparent that their internal organs are seen clearly. It is one of the marvels of nature that, in these tiny worms, there are a nervous system, digestive system, and most of the other organs that one would expect to find only in larger animals. Most of the color seen in fresh-water nematodes results from food eaten or from a coloring of the intestine walls.

TO OBTAIN a collection of fresh-water nemas, place in a watch glass or other shallow, transparent dish, a small quantity of mud or sand from a pond or stream bottom. Examine it with a hand lens, with the lowest power of your microscope, or with a dissecting microscope. Watch for the characteristic wriggling or wavy motion of the nemas, a motion which continues while the worms remain in the same place. With a medicine dropper or fine-tipped pipette, you can pick up these worms and transfer them to another watch glass. Then, with a needle or slender camel's-hair brush, and still using the dissecting microscope, you can pick up the individual nemas and place them in a drop of clear water on a microscope slide for close examination.

Another method is to place the water, containing sand and mud, in a test tube or beaker and stir or shake it thoroughly. Let it stand for a few seconds, until the heaviest sand particles have settled to the bottom. Pour off the muddy water carefully, leaving the sand behind. Most of the nemas will go with the water. Now let this water stand for three or four minutes in a beaker about four inches deep; then pour it off carefully, so as to leave a layer of sediment on the bottom. This sediment will be found to contain nematodes in great numbers, which can be captured and placed on a slide as already described.



CAPTURING NEMAS AND PREPARING THEM FOR THE MICROSCOPE

1 Place some muddy water from a stream or pond bottom in a transparent dish and let it stand. After the particles have settled, pour off the water into a beaker

2 To put the nematodes to sleep, dissolve a few drops of chloroform in some water and transfer the worms to the solution with a medicine dropper or fine brush

3 Another way of killing nemas is to heat the water containing them by holding the microscope slide over a match or candle flame

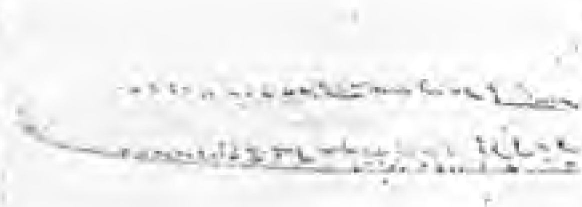
4 Individual nematodes are easily moved from the shallow dish to the slide with a camel's-hair brush of the type used by artists

FOR examination at low or moderate powers, ordinary one by three-inch glass slides, with cover glasses, can be used. But for high-power work, such as detailed examination with oil-immersion objectives, and when similar objectives are used as substage condensing lenses, two cover glasses are preferred by nematologists.

To prevent the cover glass from crushing the delicate bodies of the nemas as a result of capillary attraction, it is necessary to block it up. This is done by placing beneath it spacers consisting of strands of spun glass, or hairs plucked from a camel's-hair brush of the kind used by artists. Three hairs arranged in triangular fashion about the nemas will be satisfactory.

If you desire to see any details of the internal organs, you will have to do something to slow up or stop the incessant wriggling. This movement, incidentally, always takes place in an up-and-down direction. However, when you place the nematode between a slide and cover glass there is not enough room for it to wag its tail vertically, so it has to move parallel to the surfaces of the glass. Therefore, most microscopic views of nematodes show their sides.

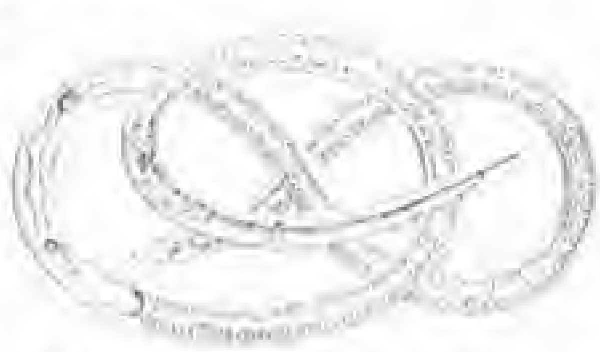
To put a nematode to sleep or kill it, you can use water in which a small quantity of chloroform has been dissolved. Fill a test tube a third full of water, add several drops of chloroform, and shake the mixture. Then put the nema into this water. Instead of chloroform you can use ether, chloral hydrate, or any other narcotic or anesthetic. Even tobacco smoke bubbled through the water will serve.



Head of a vinegar eel, photographed by "relief lighting" from the microscope's mirror

Another way of killing nemas is to heat the water containing them by holding the microscope slide above the flame of a match, candle, or Bunsen burner, until motion ceases. The specimens can be examined immediately, or preserved indefinitely by fixing and hardening in a suitable solution such as Flemming's, bichloride of mercury, or four-percent formalin, and then treating them as follows:

After the fixing and washing of the specimens, transfer them to a five-percent glycerin solution (one part glycerin to nineteen parts distilled water), and set aside until the water evaporates. This process requires usually two or three days but may have to be prolonged several weeks for very delicate specimens. When the water has evaporated, the nemas are in pure glycerin. Finally, mount in pure glycerin or in glycerin jelly.



The vinegar nematode, as sketched by a nematologist of the Department of Agriculture

This jelly, a handy mounting medium for specimens not completely dehydrated, is made as follows. Soak a quantity of dry gelatin in cold water for about thirty minutes, until it becomes soft. Drain off all the water, leaving nothing but the swollen gelatin. Warm this in a double boiler until it melts. Add a small quantity of white of egg (egg albumen) and stir thoroughly. The heating causes the albumen to coagulate into a precipitate that carries away all impurities, leaving the gelatin clear. Filter the gelatin through hot flannel and add an equal volume of glycerin, and about one gram of chloral hydrate for every gram of gelatin used. Mix the ingredients by shaking. Let the jelly stand in a warm place until the bubbles rise and disappear. In mounting, take care to avoid including air bubbles under the cover glass, because they will not work their way out as they do when balsam is used.

Recording Microscopic Subjects With Paper and Pencil

THESE simple set-ups will help you in making pencil sketches of the interesting things you see with your microscope. At the right, a mirror suspended from a stand combines with a cover glass mounted on the eyepiece to superimpose the image of the paper over the field of view. In Fig. 1, below, the microscope is used as a projector with its tube horizontal, a mirror reflecting the image onto the paper for tracing. Fig. 2 shows a right-angle prism substituted for the mirror. In Fig. 3, the observer looks downward through a thin cover glass and sees an image of the microscopic subject laid over the paper, so that it can be easily traced. In addition to its value in recording the appearance of nematodes and other subjects that do not photograph easily, sketching helps to fix details in the memory, and develops habits of close observation. A good free-hand artist can work without these aids.

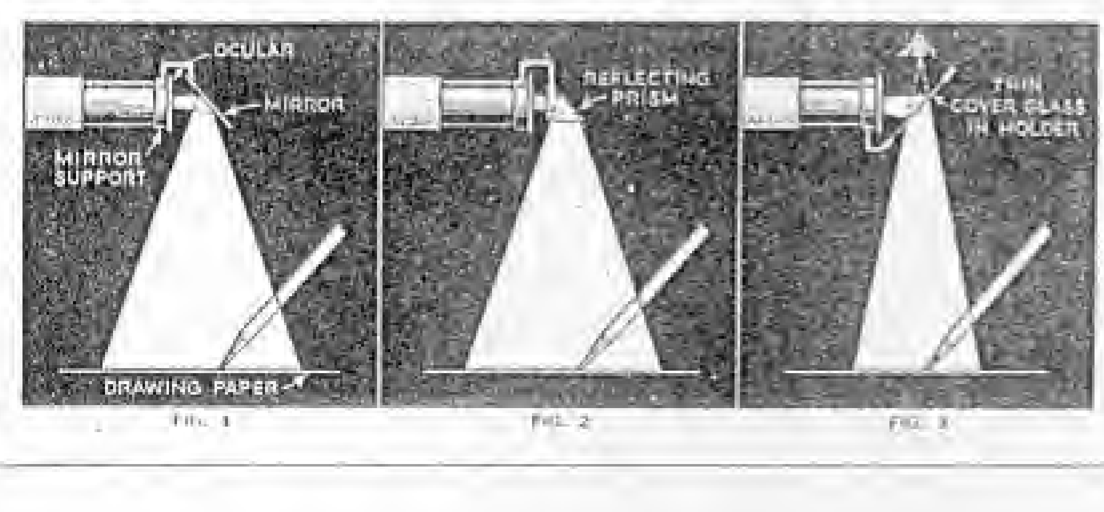


FIG. 1 FIG. 2 FIG. 3

IF GLYCERIN jelly refuses to harden when cooled, it either contains too much water, which can be removed by warming over a water bath, or was heated too much in being melted. In mounting a specimen, warm the jelly to render it fluid, and warm the slide and cover glass to prevent sudden cooling.

A nematode is incased in a tough, transparent layer or "skin" which generally consists of two laminations, the cuticula and subcuticula. Nematodes shed their skins like snakes, so that the under layer later becomes the outer one. Each of the two cuticular layers is, in turn, composed of several other layers, usually three.

Careful observation will reveal that the skin of almost every nematode is marked by fine lines or striations running across the body, at top and bottom, but not traversing the sides. One cause of these crosswise markings is found in the endless whipping of the worm's body in characteristic nematode fashion, and the consequent alternate stretching and compressing of the cuticula.

Sometimes it is possible to separate the skin of a vinegar eel by adding a few drops of absolute alcohol to the drop of water on a slide containing the tiny worm. This causes the internal organs to separate from the incasing walls and shrink into a slender line extending from end to end of the cuticular cylinder,

probably by absorbing water from the worm's insides. If a cover glass is dropped over the specimen, and a drop or two of some stain such as Loeffler's methylene blue solution is added to the cover glass edge and allowed to diffuse underneath the glass, the almost invisible cuticular sheath will be brought out plainly, the dye remaining outside it and thus marking the sheath boundaries.

If you find a nematode with a thick, loose skin, you can watch it in the process of molting. During its growth, a nematode sheds its outer covering, and the lining of its mouth, esophagus, and rectum about four times. In species having fine teeth in the pharynx, two and sometimes three complete sets of teeth can be seen, for these are shed along with the cuticula.

The digestive system of the nema includes a mouth that is adapted either to biting or sucking; and the esophagus, intestine, and rectum. There are glands in the mouth to aid digestion. Nemas with movable, muscular lips frequently have toothed gripping organs.

The esophagus is seen in a variety of forms, from a simple tube to a complicated organ having a bulblike swelling useful in exerting powerful sucking forces. The intestine is essentially a long tube, although there is in some specimens the suggestion of a stomach at the front end.

The nematode has no heart-and-artery circulatory system as do higher animals. The body cavity contains a colorless fluid that splashes about irregularly as the body is moved, bathing the organs. Perhaps the constant whipping action of these tiny worms is to their circulatory system what the beating of a heart is to that of larger animals.

ENCIRCLING the esophagus, near the middle of the neck, is a ring-shaped bundle of nerve fibers that form a simple brain. Extending from it to other parts of the body are nerves which control the organs and muscles. Several species have distinct eyes or eye spots, sometimes equipped with tiny lenses which probably act as light collectors rather than image-forming devices. Running back from the eyes to the nerve ring are nerve fibers.

Other important organs visible to the microscopist include the sexual apparatus, hairs or spines which apparently serve as tactile hairs for feeling the way past obstacles, and several items whose use remains a mystery.

Among the most prominent of these mysterious devices are the "lateral organs," two sense organs situated on the outside of the head, one on either side. The function of these organs is thought to be that of a chemical sense organ. The outer parts of these organs may be in the form of a spiral, circle, helix, or merely a straight projection. They are directly connected with the central nerve organs.

Nematodes cause millions of dollars worth of damage every year and are responsible for a great many deaths. Hookworms, which attach themselves to the intestinal walls and drain the energy of their host, are nematodes. So are the worms that are found in sheep, hogs, and many other domestic animals. The dreaded trichina worm, which by burying itself in the muscles of a pig causes the disease known as trichinosis in the animal, and in humans who eat improperly cooked pork obtained from such a slaughtered pig, is among the most dangerous of nematodes.

MUCH of the research work carried on by Government nematologists is directed towards combating the nemas which attack such useful plants as wheat, sugar beets, and strawberries. The root-knot nema, one of the worst of this class, is known to attack nearly a thousand different plants.

The Nematology Laboratory of the U. S. Department of Agriculture is one of the most unusual and important workshops operated by Uncle Sam's scientists. Here highly trained workers do nothing but study nematodes, make marvelously detailed drawings of them, develop better ways of seeing them with microscopes, work out methods of combating their destructiveness, and even learn how to put some of them to useful work! They have discovered one kind of nema that will attack and devour another nematode whose specialty is damaging citrous-tree roots. There are nemas that kill insect larvae, destroy the eggs of such injurious insects as grasshoppers, and even transmit diseases which kill destructive insects.

In the nematology laboratory at Washington you will not find much photomicrographic activity. No satisfactory method of recording photographically the delicate details of nematodes has been developed, so the nematologists are at the same time expert artists. The making of a complete drawing may require months of work and thousands of observations. Efficient drawing equipment, head-rests that reduce the fatigue of hours of observation, and the best microscopes in the world are used. Still, much of the success depends on downright skill and patience of the observer.

Wonders of SEA SHELLS Shown by Your Microscope

Examination Reveals How Nature Fashions Beautiful Coverings for Common Mollusks

POPULAR SCIENCE MONTHLY JUNE 1936

By MORTON C. WALLING

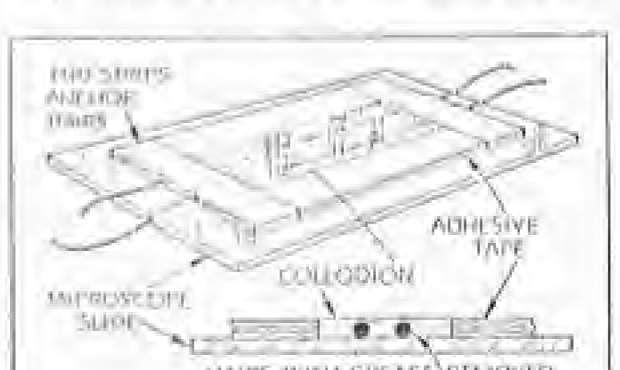
OF THE many reasons why adventuring with the microscope can be such a fascinating hobby, not the least is the fact that it lends new and unsuspected interest to apparently simple, commonplace objects. Consider, for example, that bit of sea shell on your work table.

The shell was produced as half of the outer covering of a bivalve, a mollusk related to the oyster and similar marine animals. Examine it closely with your unaided eyes. The outer surface of this particular specimen is, perhaps, a mixture of colors—black, brown, and a grayish white; and it is broken up into steps, roughly parallel. Turn the shell over, and you find that the concave side glows with an iridescent, pearly luster. Colors of the rainbow play over it. This is mother-of-pearl, or nacre.

A simple thing, this shell. Yet, to produce all these colors and that iridescence must require some hidden mechanism, or at least something not visible to the naked eye. It is time to turn to your microscope. Here begins a new series of thrills; for, in order to find out all you can about that shell, you will have to perform numerous interesting operations on it—operations, by the way, which are applicable to the preparation and study of a great many other things of interest to the amateur microscopist.

First, as with all things, this particular shell is to be given a general examination at moderate powers, say at fifty or seventy-five diameters. Hold the shell up to the light. It is so thick that it is only slightly translucent, for the most part. But near the edge, are several spots which are almost transparent. Lay the shell on a clean glass slide, move it until one of the nearly transparent spots is beneath the lens, and focus carefully.

Surprise No. 1! The shell is not the homogeneous, uniform structure you thought it was. Seen at seventy-five times its original size, it becomes a miniature mosaic of colored stones, fitted together with a perfection that is little short of uncanny. It reminds you of a tiled pavement. Most of the little blocks have six sides, although there are some with only four, and others with more. But how beautifully they are fitted together!



Studying Human Hairs With Collodion Casts

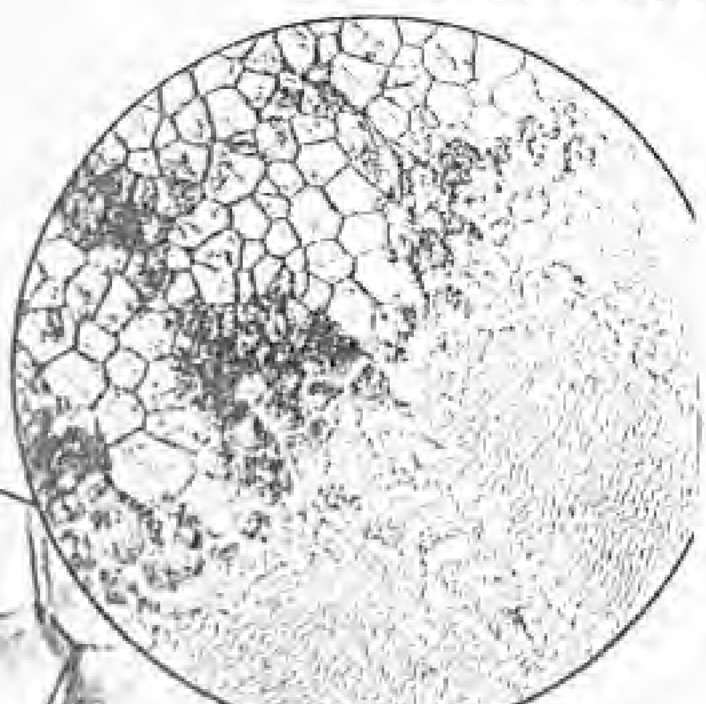
The surface markings of human hairs are easily studied by means of collodion casts. To make such a cast, wash the hairs in a solvent like xylol to remove grease. Next, place them on a glass slide, fastening the ends with strips of adhesive tape, and build up a rectangular wall around them with other pieces of tape. Into this well the collodion is poured. When it has set firmly, peel the cast from the slide and pull the hairs from the collodion bed. The cast is then mounted in the customary manner for microscopic work.

Now turn the shell over so that its pearly side is uppermost. Again focus near the edge, over one of the nearly transparent spots where the pearly luster seems to be lacking. Again you see that wonderful mosaic, only, perhaps, smoother and more perfect; for you noticed that, on the outer surface, some of the little "stones" had a scaly appearance. These on the pearly side, however, are perfectly smooth.

Now move the slide sideways, until the point of focus moves toward the center of the shell. The appearance of the surface, as you refocus your lens, changes abruptly. Now, instead of the cobblestone pavement, you are gazing at something that remotely resembles the surface of a piece of wood with prominent grain. There are scores of fine lines, curving and circling about, each managing somehow to be almost parallel to its neighbor on either side. At a higher magnification, and with careful manipulation of the light (which must be incident, not transmitted), you discover that these gracefully sweeping lines are themselves kinked and wavy. Thus you find that mother-of-pearl—for that is what you are examining—is marked by characteristic wavy lines which, somehow, have much to do with the iridescent appearance of the material.

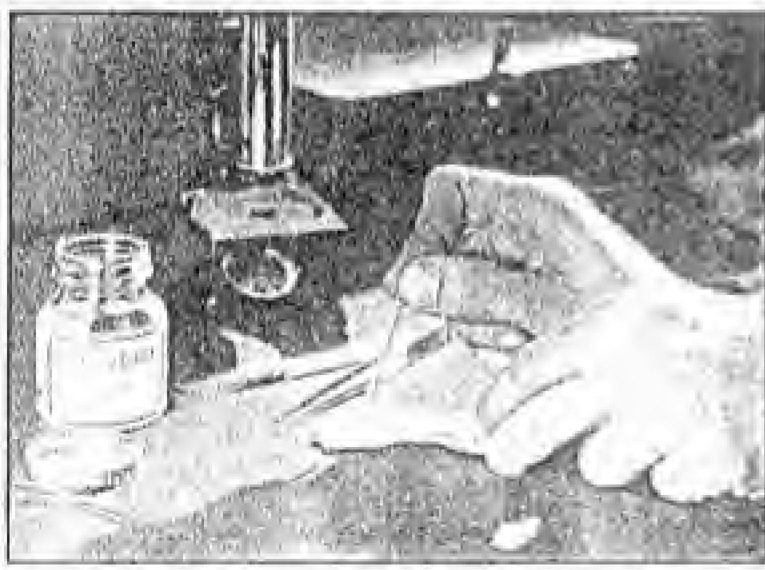
By studying the surfaces of the shell, it is not always easy to determine exactly whether some of the markings are ridges or grooves or other irregularities, or whether they are merely the result of pigmentation. There is an easy and striking way of finding out. It is, incidentally, a little trick that can be used for revealing hidden details in a great many other objects.

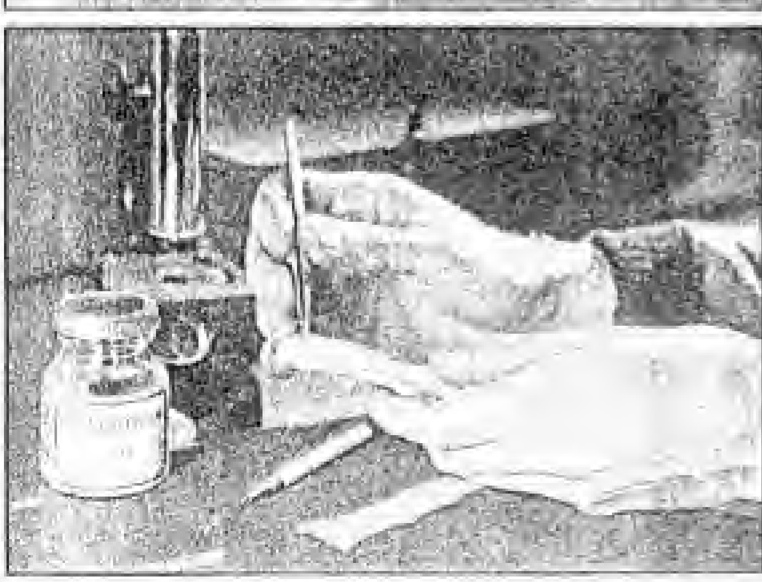
The magnified shell section at right was ground and polished on a hone. Below, cell structures after removal of lime by a weak acid. Note the irregularity of the cell formations



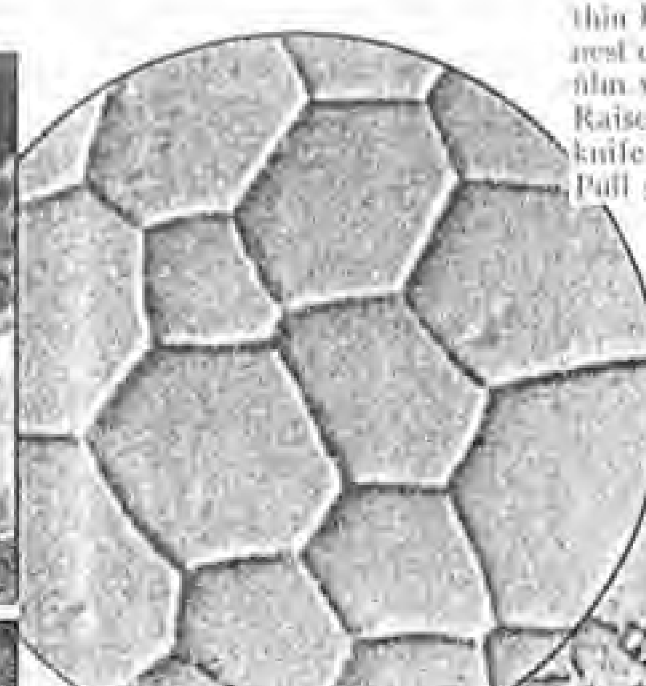
Go to the drug store and get an ounce of flexible collodion. This is a solution of guncotton or pyroxylin in ether and alcohol, and consequently is very inflammable and even explosive under certain conditions. So, in handling the bottle, use the same precautions you would with so much gasoline or pure ether. *Keep flame away from it.* Instead of collodion, a solution of celluloid in acetone can be used.

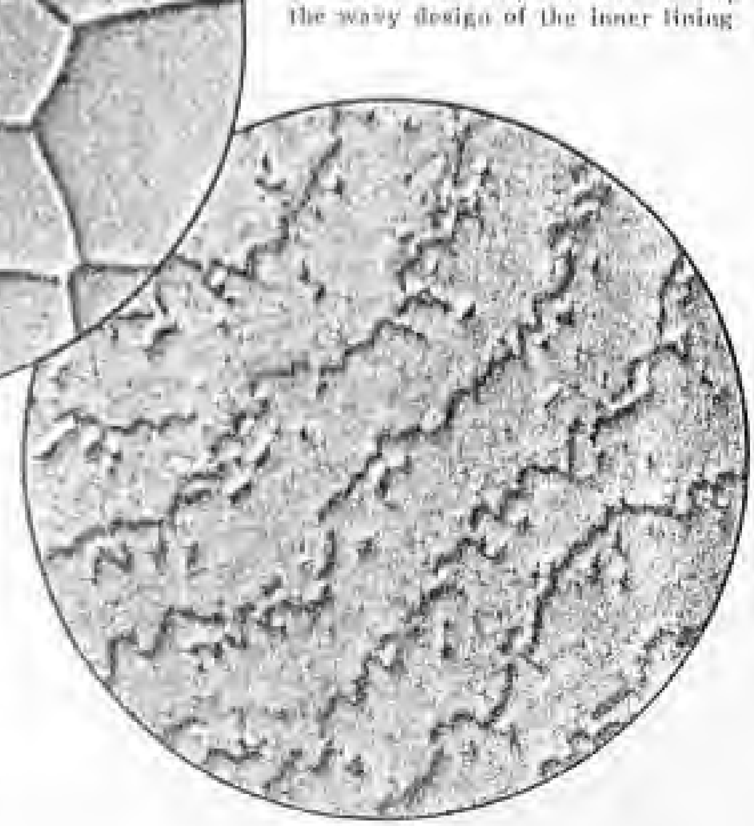
With a toothpick, place two or three drops of collodion on the inner, pearly surface of the shell, and spread it out in a thin layer that extends to one of the thinnest edges. In a few minutes, the hardened film will be dry enough to permit peeling. Raise one edge with a needle or sharp knife blade, and grasp it with tweezers. Pull gently and evenly, and the film will





Transparent casts made of collodion are used to study the surfaces of shells. The photomicrograph at the left shows the mosaic pattern of the outer surface; the one below, the wavy design of the inner lining





PREPARATION OF A COLLODION CAST

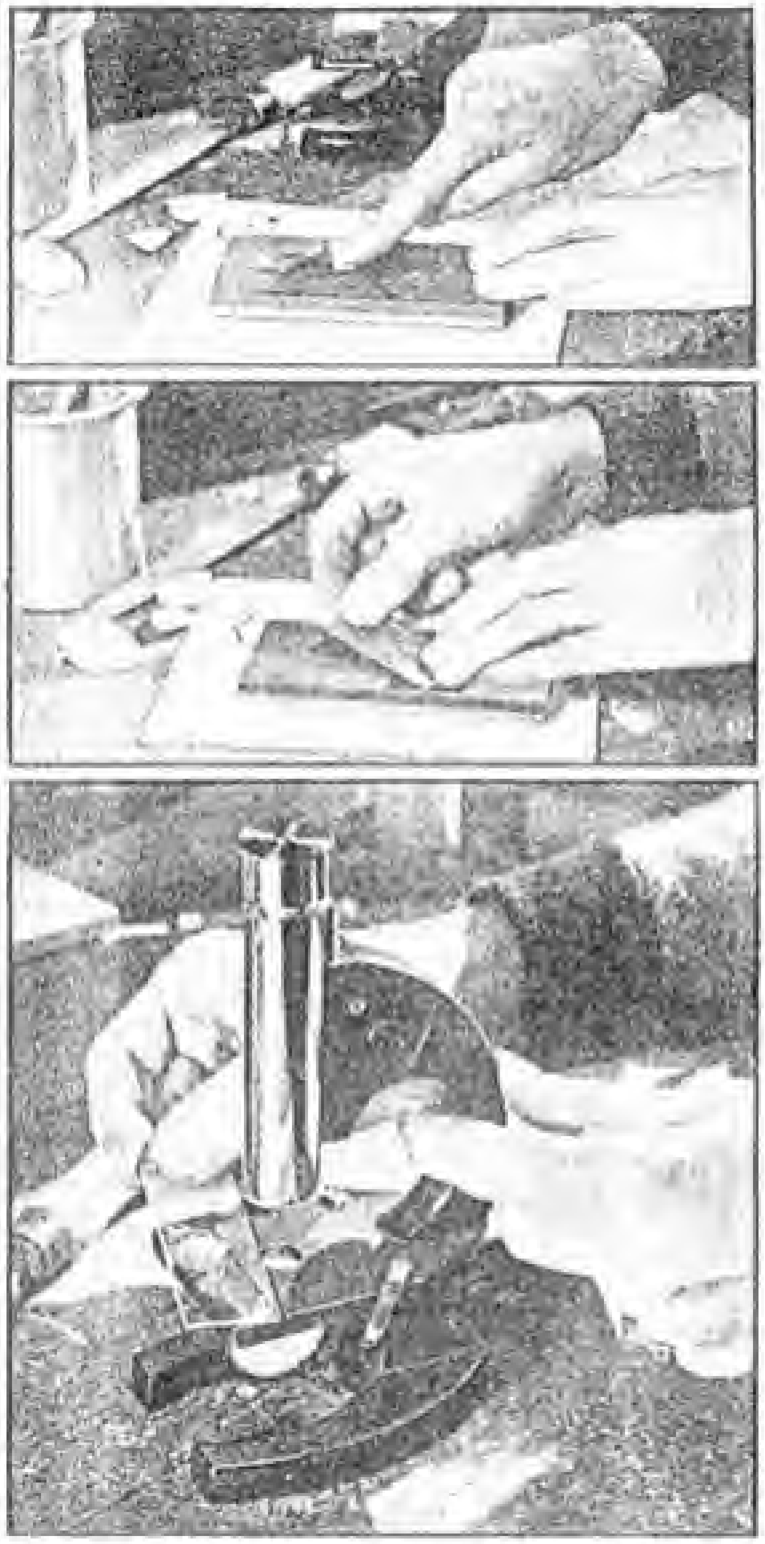
Two steps in preparing a collodion cast of a shell: In upper view, a few drops of collodion are being spread on the inner, pearly surface of the shell; left, with the aid of tweezers, the dried collodion film is carefully removed from the shell surface

come off in a single piece, or at least in a piece large enough for observation. Be sure that you peel off some near the shell edge. Transfer the film to a clean microscope slide, laying uppermost the side that was in contact with the shell. In a similar way, make a collodion cast of the outer surface of the shell.

Examination at 100 or so diameters reveals that you have captured considerable beauty in those simple pieces of pyroxylin. There is the mosaic pavement near one edge of the first film. The individual blocks are smooth and even. Now look at that from the outer surface, and you find that the blocks are not so smooth, but are roughened in spots, where the shell has encountered sharp stones and the like. The cast of the pearly surface resolves itself into a series of wavy lines very much like those you saw on direct inspection. You still can see the iridescent colors by tipping the film to various angles while looking at it with your naked eyes. This little experiment seems to indicate that the iridescence of mother-of-pearl is largely a result of surface ridges and grooves, which, because of their fineness, break up the light rays into prismatic colors.

This making of collodion casts is a stunt worth remembering. You can use it often in microscopy, for revealing details of objects that cannot be lighted or otherwise made suitable for direct observation. Human hairs, for example, prove difficult subjects to the microscopist who attempts to see their surface markings distinctly. These markings, incidentally, are somewhat like those on mother-of-pearl, but do not cause pearly iridescence. With the aid of collodion, inspection of hair surfaces, as carried out in criminological laboratories, is easy.

The hairs are first washed in a solvent that removes grease, such as xylol. Then they are laid on a glass plate and their ends fastened down with adhesive tape or paper. A little boxlike, shallow well is built around the hairs with the tape. Into this depression is poured a sufficient quantity of collodion to fill it. When the collodion has become firm, it is peeled in a sheet from the glass; and the hairs are then pulled away from it, leaving perfect impressions of their surface markings. The collodion cast is mounted on a slide and inspected by transmitted light.



HOW TO MAKE THIN SECTIONS OF SHELLS

Top view, the microscopist ready to examine a polished shell. The lower pictures show stages in preparing the shell. First, the section is ground on a hone. Then, with the ground and polished side cemented to a slide, the process is repeated on the other side. Frequent examination will prevent overgrinding

YOU can make similar casts of various other things. A cast of a portion of the surface of a coin will reveal the tool marks of the die maker, or the pits formed by oxidation of the metal. The surface of metal that has been highly polished and then etched with nitric acid or some other reagent, in the manner usually employed for preparing metal for microscopical examination with a vertical illuminator, will leave an imprint of the crystalline structure of the metal on a collodion film.

Usually, the films are seen best when examined dry. That is, you simply place them on a clean glass slide, marked surface uppermost, and lay over them a clean cover glass. The glass can be fastened down at the edges with gummed paper, shellac, or other material, for permanent preparation. In examining the films, you will be surprised at the variety of effects that can be produced by changing the mirror angle, masking off one side of the light beam from the mirror, and similar stunts. With a little experimenting, it usually is possible to produce the effect of relief, as seen in some of the accompanying photomicrographs of film casts.

But, so far, you haven't found out a great deal about the actual structure of the shell under consideration. One path of further exploration leads to the making of thin sections of shell. That is, you put the shell through a process that produces a very thin slice, either at right angles to the surface or approximately parallel to it. The parallel section is easiest to make. Break off a piece of shell about as big in area as the cross section of a lead pencil. This piece will be slightly saucer-shaped in most cases. Obtain a two-surfaced razor hone, or two hones, one fine and the other coarse. Wet the coarse hone, lay the piece of shell on it with the dished-in side uppermost, and with your finger rub the piece back and forth on the hone until it is ground flat. Then transfer it to the fine hone, and bring to as high a polish as possible. The finer the hone, the more perfect this polishing will be.

PLACE a drop of Canada balsam in the center of a clean microscope slide, and warm it gently over a gas flame or a little electric stove like that described in a recent article (P.S.M., Feb. '36, p. 44). Heat the balsam until most of the solvent has evaporated. Do not overdo it. While the balsam is warm and sticky, lay the piece of shell, previously washed and dried to remove dirt, on it, polished side down. Press firmly against the glass, and set the slide aside to cool.

When the balsam has hardened, grind the other side of the shell down, and polish in the same manner as for the first surface. Because it is possible to overdo the grinding, examine the specimen frequently through the microscope as the section becomes thin. When the polishing is finished, wash the specimen well, put a drop of water over it, lay a clean cover glass on, and you are ready to study the interior structure of the shell.

You see the same mosaic-pavement formation, except that the blocks are now all of the same level, and perfectly smooth. Move the slide sideways, and you suddenly find a boundary where the block pavement ends to give way to an entirely different formation. This new section seems to be made up of innumerable wavy lines, which run in every direction, but seem to have a general systematic arrangement in one direction. They look very much like the grain of yellow pine or a similar wood. This is the mother-of-pearl material in thin section.

IF YOU make a section perpendicular to the surface of the shell in the area that shows a mosaic effect in a section parallel to the surface, you will find that there are a great many more or less parallel lines, looking somewhat like a handful of matches viewed from the side.

And thus you have discovered the nature of the mosaic layer. It is composed of numerous blocks of some hard material, each block being, in most cases, hexagonal in shape. When blocks are in position, they extend from outer to inner surface of the layer, their length determining the layer thickness. Thus when you polished the first piece of shell to make a thin section, you were cutting a great many blocks crosswise. The mother-of-pearl, in cross section, shows a wavy, laminated formation.

The hexagonal blocks are crystals of lime, or calcium carbonate, a material common in bones, teeth, and all mollusk shells. Lime is a very convenient material for all animal forms

to employ. It can be used in so many shapes. One of the most beautiful pure-lime formations is seen by looking at a little block of cuttlefish "bone" with a microscope.

But to get back to the shell in question. If the blocks are of lime, why wouldn't the shell disappear if immersed in weak hydrochloric or nitric acid? Why not try it? Make a solution of about one part concentrated hydrochloric (or nitric or sulphuric) acid in ten parts water. Undiluted vinegar can be used, if no other acid is available. Drop into the acid solution a piece of the shell. Also, while you are at it, immerse the slide bearing the thin section of shell—the one made parallel to the shell surface—removing, of course, the cover glass. Set the acid containing the specimens aside over night.

IN THE morning, you will find that the shell has not disappeared, but that, for the most part, it looks very much as it did before, although it now is limp and flabby. The microscope reveals that there are the same mosaic blocks, and the same wavy lines on the inner surface. With a pair of dissecting needles, tear apart some of the mother-of-pearl material. This is easy, for the shell now consists only of animal tissue, without the strength-giving lime.

The mother-of-pearl resolves itself into layers of thin membranes, which the microscope shows to be folded in innumerable fine creases. These membranes, when properly illuminated, exhibit beautiful coloring. Stretch one of the membranes out, so that the creases disappear, and the iridescent colors likewise vanish. Mother-of-pearl, therefore, is a formation of properly folded membranes arranged in layers whose edges are visible on the surface of the piece; and these membranes normally are reinforced with supporting infiltrations of lime.

Examine the slide bearing the shell section, and you find that the mosaic pavement has become a network of honeycomb cells. Tilt the substage mirror first one way then the other, so that the light beam strikes the specimen at different angles, and you may be able to catch a third-dimension glimpse of the sides of these cells, as shown in one of the accompanying photomicrographs. The piece of decalcified shell that was not ground reveals, when examined, that each of the cells that used to house a limestone prism is capped on each end with the same animal membrane.

THUS a typical shell of a mollusk such as the mussel and oyster is made up of three general layers. Inside is the mother-of-pearl layer of laminated, folded membranes and limestone. Next is the mosaic layer of column-like limestone crystals. Then, outside, is a very thin layer of tough membrane, which extends down between the crystals; and which is believed to protect the limestone from the action of the acids encountered in the water in which the animal bearing the shell lives. In many shells, the mother-of-pearl lining stops short of the shell edge.

You will not find this exact formation in all shells. In most of them you will find variations of one sort or another. The best shells for your first researches are, as already mentioned, the mussel, oyster, and similar bivalves.

As far back as 1870 or thereabouts, a microscopist named George Rainey described a method of making "artificial shell" resembling in many ways the prismatic layers of certain natural shells. This is Rainey's method:

Make separate solutions of a soluble compound of lime (calcium carbonate or ordinary slaked lime), and potassium or sodium carbonate. Ordinary washing soda is sodium carbonate. Mix with each solution some viscid animal substance such as albumen (the white of an egg). The quantity of the animal substance in each solution should be such that, when the two solutions are mixed, the density of the resulting solution will be the same as that of the carbonate of lime solution alone. Set the resulting mixed solution where it will remain undisturbed for about three weeks. The crystalline layer, composed of limestone crystals imbedded in the animal material, very much like that in natural shells, forms over the sides and bottom of the vessel. Rainey found that no further crystalline growth takes place after about six weeks.

MOSS—Two Plants *in* One

. . . *Strange facts shown by your* MICROSCOPE

By MORTON C. WALLING

POPULAR SCIENCE MONTHLY SEPTEMBER, 1936

Home-grown moss producing spores. When viewed under the microscope this plant reveals an odd dual personality. It has two different plant forms and reproduces itself by two entirely distinct methods

TO THE amateur microscopist, nothing revealed by his instrument is more fascinating than the unsuspected qualities possessed by objects formerly thought commonplace. Look at any minute plant or organism with the naked eye and it seems simple enough. But under the microscope, what a different story is revealed! Look, for example, at ordinary moss, and then go to the microscope to learn for yourself the story of this peculiar and widely spread member of the plant kingdom.

Moss has what psychologists would call a "dual personality." What most people regard as an ordinary plant is actually *two* plants, each completely distinct from the other. That part which we commonly call the moss plant is in actuality a separate plant, with sometimes a second plant perched on its head!

Under the all-revealing eye of the microscope, we see the evidence of one of the ingenious ways nature has devised to assure propagation of plant life, and in the process we come upon one of the most fascinating biographies in the plant world.

The common moss you see in fields, on rocks, and even along city curbstones, is of world-wide distribution. It is particularly abundant in temperate and arctic regions, where it grows in places that will support no other life, unless it be the lichen. In addition to the common moss, with which you are familiar in a general way, there is a large group of sphagnums or bog mosses, found wherever there is marshy ground. These mosses do not contain much green coloring matter, and therefore are somewhat dead in appearance. They form dense mats which gradually sink to the bottom of the bogs and eventually may be converted into peat. Another close relative of

Spores emerging from a capsule of moss sporophyte. The photomicrograph above clearly shows, at the right, the tiny tip of the case which resembles a dunce cap in shape

Although this seems to be only one plant it is actually two. The bulblike case, with its long, thin filament, is a distinct plant while the leafy structure from which it seems to grow is in reality a separate plant. Spores are scattered to the wind when the tip of the bulblike case falls off

the true moss is the liverwort, found on old logs and tree trunks.

But the kind of moss we are going to examine with the microscope is the common, everyday variety. You can collect some of it in almost any field or garden. A pocketknife and a jar or dish are all the equipment you need. After you have found a patch, cut a few sections out of it, making sure that you go an inch or so beneath the apparent surface of the ground. Be sure to obtain some plants that have long, slender stalks extending upward for perhaps a half inch, and ending in small, oval pods—the specimens which will interest us.

When you have returned to your microscope, lay out a number of clean slides and cover glasses, get a tumbler of clean water, and have within reach the usual medicine droppers, needles, and fine-pointed tweezers.

Clip off one of the slender stems bearing a dark brown, podlike body at its tip, and lay it on a clean glass slide, preferably under the lens of a dissecting microscope. If the calyptra, or loose, hoodlike cover is still over the bud, lift it off. With needles or a sharp-pointed knife, remove the tip of the pod. You will find that this comes off like a little cap. In fact, it looks very much like a cone-shaped dunce cap. At 100 diameters or so, the cells making up this cap are visible. Note that the edge is slightly scalloped.

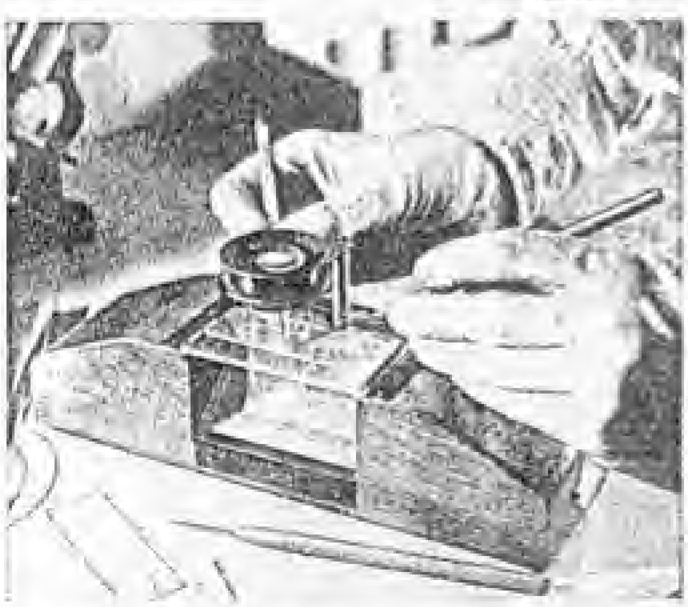
Moss growing on curbstones can easily be gathered with a knife, as is shown below

The podlike arrangement which bore the cap is a spore case or capsule. Look carefully at the open end you have just uncovered, and you will find that the edge of the case is equipped with a row of slender spikes or hairs. These are used for regulating the distribution of spores from the case. Sometimes they are folded down, overlapping in such a way that they seal the opening completely. Press the side of the spore case with a dissecting needle, and the hairs will straighten out, releasing a quantity of spores.

These spores are seen best at 300 or more diameters. They appear as little, ball-like cells, not unlike the pollen of some of the higher flowering plants. When the spores are liberated from their tiny case while the moss plant is flourishing in the field, they are carried by the wind to various places. Some of them find suitable damp areas where they can germinate.

You can see how this germination goes on by planting some spores in a pan or pot of damp earth. Select those from a ripe, almost black, spore case. Watch the germination of the spores carefully with a hand lens and by looking at small samples with the microscope. You will find that they do not grow at once into the green, leafy moss plants you probably expected. Instead, they produce patches of branching filaments, which look very much like some of the green algae you have seen in ponds and lakes. The spores with which you are dealing now are of the asexual type—that is, they were not produced by sexual organs of the moss.

The algalike growth, or protonema, spreads over the earth in a thin, green layer. Ordinarily, this mass of slender, almost-invisible threads goes unnoticed by anyone except the biologist or exploring microscopist. Under the microscope the protonema strands are decidedly green in color. Mixed with them you may find dark, brownish filaments. These are the rhizoids, rootlike structures sent out by the leafy plants



Removing spores from a moss sporophyte with the aid of a dissecting microscope and needles so that they may be sown in a small pot where they will reproduce

When moss spores have been taken from the sporophyte, they are then shaken into some sterilized earth

Water, poured into a saucer under the flowerpot, is absorbed by the dirt, providing plenty of moisture

which grow up from the protonema strands.

After the protonema has started to spread, little swellings appear here and there. These grow into buds which eventually develop into upright stalks from which grow small leaves, pointed and very green. These branches sent up by the hiding protonema are the "moss plants" most people know.

The leaves make interesting objects for microscopic study. They are of relatively simple construction, you will find, and consist of a mass of chlorophyll-filled cells laid side by side, much like the bricks of a pavement. Along the center is a thickened area, composed of compact, thick-walled cells. This probably is a stiffening member, and the forerunner of the elaborate system of veins found in leaves of plants higher in the scale of botanical life than the moss.

THE tips of the leafy branches, or the tips of smaller branches extending from them, develop into rosettelike structures in which are concealed the sexual organs of the moss plant. The male and female organs may be found in separate stems, or on the same stem, depending on the kind of moss.

The male stems, which bear the antheridia, or male organs, usually are smaller than the female. The group of antheridia in the center of the stem is surrounded by a rosette of tiny, green leaves. These rosettes sometimes are called moss flowers, although they are not flowers at all, because the antheridia are yellow or orange-colored. An antheridium, or male sex organ, resembles a tiny club. There is a short stalk, on the tip of which is an oval or nearly oval bulb. This bulbous object is the sperm case, which splits open at the end when the sperm cells inside are to be released.

The female stems, bearing the archegonia, also have a cluster of leaves at their tip, which must be separated with dissecting needles in order to reveal the female organs. Each organ, or archegonium, resembles a tiny, globular bottle with a long neck. Like the male organ, it is made up of numerous cells. In the older archegonia, the necks are open, and there are egg cells in the bulbous bases.

Now, when the sperm cells in the male organ are fully developed, they wait until the moss plant is made wet by a shower or by dew. The water-soaked sperm case bursts open and the tiny sperm cells, each equipped with two cilia or "tails," swim out into the world. These two-tailed sperm cells, which swim about like tiny animals, are distinguishing features of the bryophytes, a group of plants of which moss is the best-known example.

WHEN a swimming sperm cell reaches the neck of an archegonium, it makes its way down to the bulbous base, where it joins the egg cell; this produces an oöspore or sexual spore, which starts to grow immediately. The lower part of this oöspore develops into a base or foot, which becomes firmly anchored in the tip of the leafy branch. In fact, the branch grows up about it, holding it securely. Then from the upper part of the oöspore there develops a long, slender filament, on the top of which is the podlike case or capsule in which asexual spores are developed. You can trace the growth of this spore-bearing plant, or sporophyte, by dissecting tips of leafy branches during various stages of its development.

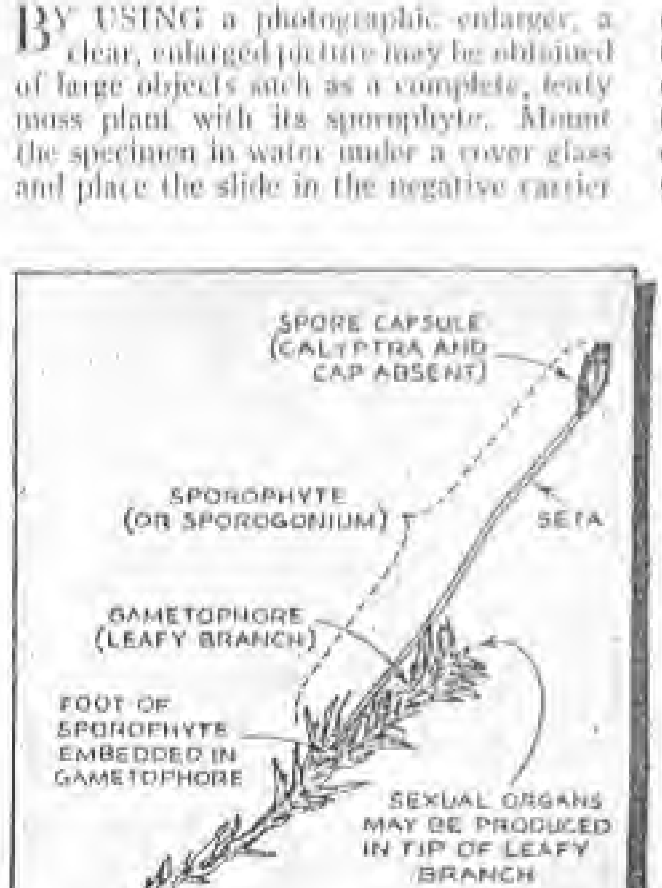
Notice that a hoodlike covering, called the calyptra, forms over the growing sporophyte; and that, as the filament grows upward, it breaks this calyptra loose and carries it upward, where it remains perched on the spore case like a monk's hood, until it falls off. While the typical spore-bearing plant consists, as you have discovered, of a foot, a slender stem, and a spore case or capsule, a given specimen may lack some of the parts. Sometimes the stem is not present, and at other times the foot cannot be found. The spore case, however, is always there, as it is the important part of this phase of the moss plant's life cycle. The spores produced in this case germinate to form the protonema, and the life cycle is repeated.

TO SEE clearly how the moss leads a double life, look again at its life cycle. The asexual spores grow into a network of filaments resembling algae plants. From these there rise leafy branches which bear sex organs. These sex organs join in reproducing an oöspore. Thus one chapter in the moss plant's history is complete.

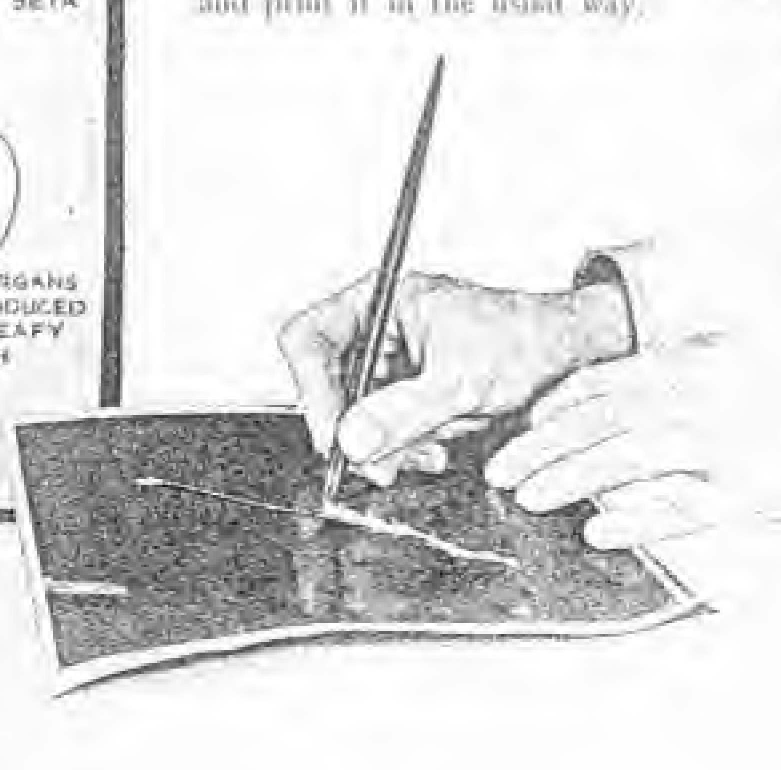
Then the oöspore grows into a leafless, capsule-bearing plant which, without the aid of sexual equipment, produces a new collection of spores. Here the other personality of the moss plant is seen. These asexual spores, when

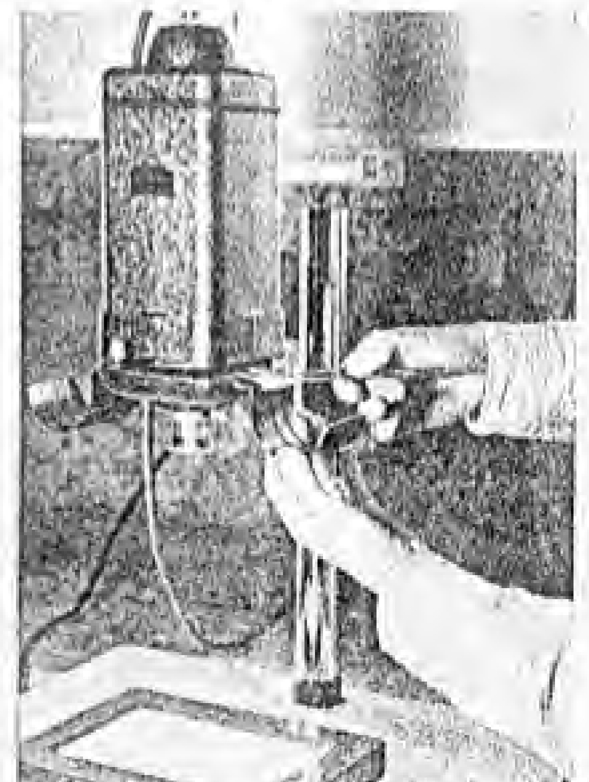
Enlarger Aids in Photographing Large Microscope Subjects

BY USING a photographic enlarger, a clear, enlarged picture may be obtained of large objects such as a complete, leafy moss plant with its sporophyte. Mount the specimen in water under a cover glass and place the slide in the negative carrier of the enlarger. Focus the image of the specimen on the easel and place either a sheet of bromide enlarging paper or a sensitized film on the easel and make the exposure. The outline on the paper negative can be traced with waterproof India ink and the photographic image bleached out with a solution made of tincture of iodine in from two to ten parts of water, after which the paper is immersed in the hypo fixing bath. Positive prints may be made by using either bromide or chloride paper. Simply put the sheet in a printing frame against another piece of sensitized paper, with the coated surfaces touching, and print it in the usual way.



A sketch of a moss branch and sporophyte made by photographing the plant on bromide paper. The image was outlined with waterproof ink, as at the right, and then the print was bleached





A photographic enlarger in use for making a photomicrograph of a spore-bearing moss plant. The glass slide on which the specimen is mounted is placed in the negative carrier and focused like a negative. Sensitized bromide paper, film, or plate, can be used

they germinate, produce a generation of leafy plants.

Note that the leafless growth that develops from the oöspore is a distinct, separate plant, although it appears to be a continuation of the leafy structure. It is entirely separate even as far as its activities are concerned, and uses the leafy stalk only as an anchorage and source of nourishment, much as a parasite plant lives on its host. You can observe the way in which the sporophyte is held by the leafy branch by slicing a number of branches with a sharp razor blade until you are lucky enough to cut one in exactly the right place to reveal the cell arrangement.

The moss plant is a good example of the way generations are alternated in the plant world. One generation is produced by the asexual spore from the spore producing plant. The other is produced by the sexual spore from the leafy, sexed plant.

In this complication of structures and activities, you can find much interesting microscope material. Most of it can be examined as simple preparations in water.

To obtain specimens of the algalike growth in the field, cut a small cube from a bed of moss, going deep enough to include a considerable amount of earth. Place the piece in a test tube, fill the tube half full of water, and shake it vigorously. Pour out the muddy water, refill the tube, and shake it again. Continue this until all the earth has been washed away. Then place a bit of the green filament mass in a drop of clean water, and examine at fifty to 350 diameters.

TO EXAMINE the entire moss structure—the two complete plants—you need only a hand lens magnifying seven and a half to ten diameters. The green leaves are placed in a drop of water and a cover glass is added. Their cellular arrangement can be seen at 200 diameters, and the structures of the individual cells, including nuclei, chlorophyll bodies, and the like, usually can be seen at 400 diameters.

The tips of the leafy branches, showing the male and female organs and the developing spore-bearing plant, are examined at moderate powers. The sexual organs are revealed by merely removing the leaves surrounding them. The developing oöspore can be drawn out with needles and examined separately.

Among the most interesting parts of the spore-bearing plant are the spores and the capsule in which they were formed. Try to find an unopened spore case that still is covered by the hoodlike calyptra. Take the calyptra off, and you will find that the spore case has at its tip a cuplike structure or lid, the "dunce cap" already mentioned. This is called the operculum. It can be removed easily with a needle. You can spend an interesting ten minutes studying it.

Along with the cap of the spore case you frequently can find a ringlike object made of a series of cells strung together like the beads of a necklace. This usually drops off when the cap is removed, and sometimes writhes around like a tiny worm, especially when it comes in contact with water. The opening of the spore case, covered by the overlapping teeth, can be studied best if it is cut away from the remainder of the case with a razor, and mounted so that the teeth show. Sometimes it is difficult to make good preparations of these teeth from fresh spore cases. Try soaking an old, blackened case in water or a solution of lye water until it becomes softened. Split it open from end to end, and mount in water.

IT IS fun to grow your own moss under laboratory conditions. Make a field expedition and collect a considerable quantity of moss, being sure to get some that is bearing spores. This is not at all difficult. Obtain one or more shallow flowerpots or similar containers, and fill them with earth. To kill fungous material that might be present, and would give trouble later, place the pot in an oven and bake it for two or three hours, at a fairly high temperature; or else sterilize it by steaming in a double boiler or similar arrangement for a similar length of time. Set the pot in a saucer of water, and sow the spores, which you previously have pressed out of their cases on a clean slide. Jar or blow the spores from the glass, so that they fall on the earth. Or hold a bunch of ripe spore cases above the pot, and jar the spores loose with a needle. Lay a sheet of glass over the top of the pot.

The earth will get enough moisture from the saucer, to which you must add water from time to time. Before long, you will see the surface turn green from the growth of algalike filaments. In about twenty days, perhaps sooner, leafy moss plants will appear. These, after a time, will develop sexual organs.

You can control the production of oöspores by the way you water your moss garden. As long as the plants themselves are not wetted directly, but receive moisture only from the saucer in which the pot is resting, the egg cells will not be visited by the sperm cells, because the sperms have to have water in which to swim. When you want to raise the second generation of moss plants, set the pot in water, or otherwise flood it, for two hours. Then return it to its saucer, and wait for the spore-bearing plants to develop. In this way you can control the production of new generations of moss, and have on hand material showing, at the same time, different degrees of development of the sporophyte.

POPULAR SCIENCE MONTHLY JANUARY, 1935

Ant's Strange Equipment SEEN IN YOUR MICROSCOPE

By MORTON C. WALLING

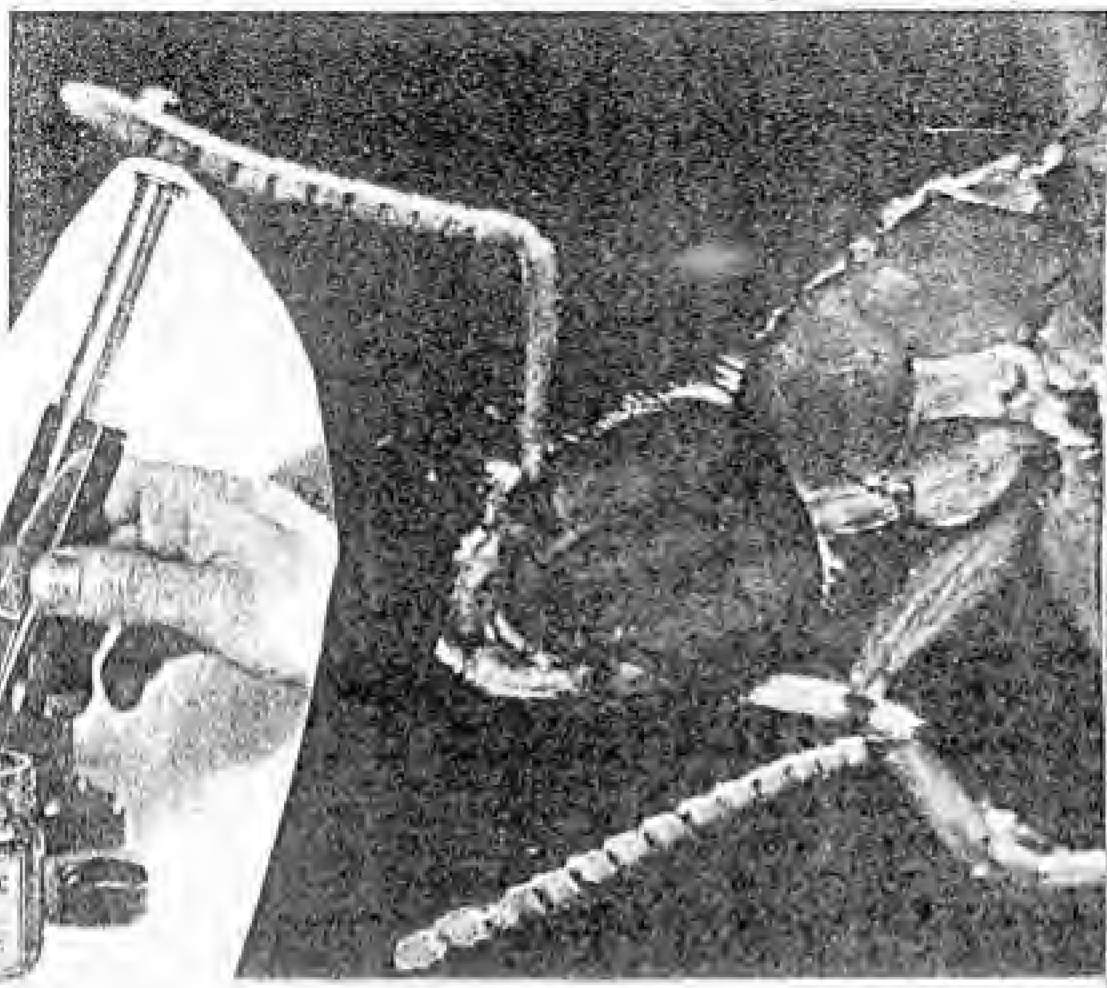
NO MATTER where you go, you cannot escape the busy ant, except on the tops of the highest mountains and in extreme polar regions. You can find ants in the dry, hot desert or the steaming tropics. If you are like most persons, you have little love for them. Rather you notice them because of mingled feelings of curiosity and fear. They seem, as you watch them going about their busy ways, to be guided by a mysterious sort of intelligence and to possess a power that is a bit threatening to your personal comfort.

If you are a microscope hobbyist, the ant will appeal to you in another way. "Surely," you will tell yourself, "such an insect ought to have a few secret wonders that my magic lenses will reveal."

Put one of these creatures on a slide and look at it at even a low magnification of twenty diameters or so, and you will marvel at some of these wonders. An

Left, magnified view of tiny hooks found along the front edge of an ant's smaller wing. These hooks fit into a groove in the rear edge of the larger wing so they lock wings together

Enlarged view at left of droplets of fat found in the body of a female ant. These furnish food during the insect's egg-laying period



Ants for microscopic study are killed by dropping them in carbolic acid. At right, magnified head of ant showing strong jaws

Foreleg of ant enlarged about 200 diameters. Note the comb with which the insect cleans its body. One part of the comb folds like a knife blade against the leg when not in use

easy way to capture ant specimens is to hold the bowl of a teaspoon where one of them will crawl into it, moving the spoon about until the insect, which at first will attempt to run around it, decides to try a short-cut. Lift the ant and deposit it in a wide mouth bottle by tapping the spoon on the bottle edge. In the bottle can be denatured alcohol or a strong solution of carbolic acid. The latter, which must be kept off skin and clothing, is preferred by some microscopists for killing insects because it renders them somewhat more transparent. Before dissecting or mounting a specimen killed in the acid, wash it well in clear water.

You will find that black ants do not make as good microscope specimens as those of lighter color, such as red, because they are opaque to light. Small red ants that you can capture in any garden are sufficiently translucent to make beautiful objects when placed whole on the slide, either dry or in water, liquid petrolatum, or other medium.

Ants are outstanding social insects. The colonies are composed of different types of individuals, like colonies of bees and certain wasps. These form the highly specialized castes including workers, queens, and males. Only the queens and males possess wings at certain periods of their development. The female workers never are winged, and frequently are comparatively small in size. In some species, the queen is several thousand times larger than the workers of her colony.

Perhaps you have seen, on a still, sultry afternoon, winged ants swarming in the air. These are males and females on their honeymoon flights. As if by a prearranged signal, all winged inhabitants of hundreds or thousands of colonies take to the air at the same time. Later most of the females pick out new home sites, which may be a hole in the earth or a tunnel beneath a stone, shed their wings, and settle down to raise a family. From this time until the first brood is hatched, the typical queen does not eat or engage in other activity. Her massive wing muscles, no longer required for locomotion because the wings have been discarded, are absorbed and converted into egg material. Individual ants in the first brood are small, because of the limited food supply. They assist their mother by bringing new food into the nest, so that the second and subsequent broods are made up of normal-sized individuals. A queen ant may lay eggs and raise families for many years. This life cycle is not followed by every ant species, but is typical of many of them.

Examine a winged ant under the microscope. You can see without much trouble that the wings, of generous proportions, require powerful muscles, so that the way in which the queen ant can exist without food while her first batch of eggs are developing becomes evident.

When you look at a worker ant, at moderate magnification, you will be struck by the well-polished appearance of her body. The armor plate fairly glistens, with a finish rivaling that of a shiny motor car. Although your specimen spent much of its time in or on the ground, you fail to see particles of dirt on its body. Why is this?

FOR the answer, switch to a somewhat higher power and examine carefully one of the fore legs of the ant. There, near the outer end of one of the sections (the tibia) is a delicately formed comb, with perfect rows of tiny teeth. It folds down, like a pocketknife blade, against the adjacent leg section or metatarsus, which likewise is toothed. Now you know how the ant keeps herself clean. She combs her body with her fore legs, drawing her other legs and antennae through the notch formed by the comb and metatarsus. Then she cleans the combs by passing the teeth through her mouth. She does not eat the dirt thus obtained, but sidetracks it to a little pocket lying just inside the mouth opening.

In this pocket she also stores, temporarily, any solid food that she may have eaten. It remains there until all the juices it contained have been pressed out. Then the pellet, formed by compressing the food and dirt particles in the pocket, is discarded. The ant, therefore, actually does not eat solid food, but only liquids. Sometimes it finds these liquids ready to drink. At other times it has to extract them from solid material in the pocket, or by squeezing a bit of solid food between its powerful mandibles. By carefully dissecting the

PREPARING LIGHT FILTER. Colored water is poured into a flask which is held in a wooden stand which is built as described in the text of this article. Light passing through the flask of colored water and falling upon the specimen increases its visibility

In preparing an ant specimen for observation beneath your lens, it is dissected in a drop of water on a hollow-ground slide as is shown in the illustration below

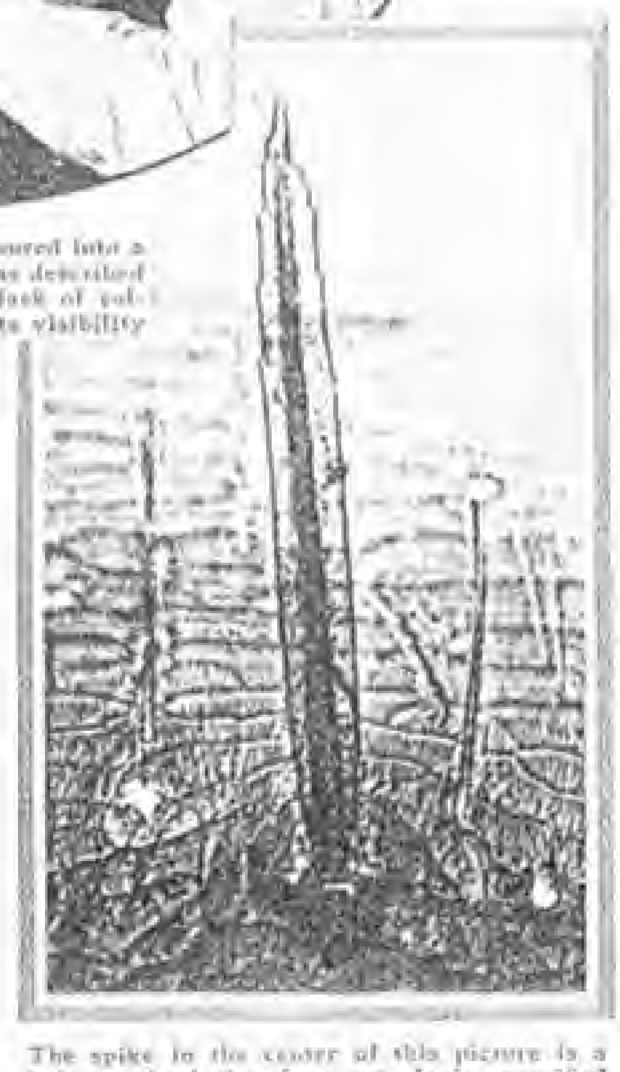
head of a large ant, you may be able to find the little pellet in the pocket just inside the mouth.

The head and mouth parts of ants vary according to species. Generally there is a prominent pair of mandibles, usually toothed. These operate somewhat like the jaws of claw-type pincers. The ant uses them as its principal tools, much as you use your hands. With them it captures and kills other insects and presses their juices out for food; it tunnels through earth or wood; it uses them as weapons in fighting; it employs them as tongs for carrying eggs, young ants, and all sorts of objects.

In addition to the mandibles, the mouth parts that your microscope will reveal include the upper lip, or labrum, lower lip or labium, and a pair of maxillae. The labium and maxillae are equipped with pairs of jointed palpi, which are sensory organs probably responding mostly to odor and touch stimuli.

Ants have existed in their present form for millions of years. One proof that scientists have of this is the specimens embalmed in amber (fossilized rosin) millions of years old. Your microscope will reveal, in a few moments, just why the ant, and insects in general, have been able to survive where apparently more highly developed animals have perished.

With a sharp scalpel split into two parts the head of an ant. This is easy if you have a dissecting microscope magnifying seven to ten times. Arrange the halves with their flat sides uppermost, on a glass slide, and examine them at moderate magnifications. If the specimen has been prepared properly, you will be able to see how the powerful mandible muscles and other internal organs are attached to the inner surface of the hard shell that forms the ant's head, or "skull." If the specimen had been partly dried in air or by dehydrating in alcohol, slicing the head will not have crushed these delicate structures.



The spike in the center of this picture is a hair on the body of an ant. It is magnified about 650 diameters. Note the ridged nature of the insect's body as seen in microscope

THE ant, therefore, carries its skeleton on the outside, where it will do the most good. In addition to providing the necessary stiffness, the skeleton acts as a suit of armor. No wonder the insects are difficult enemies to subdue when they decide to be unfriendly. Another advantage of the out-side-skeleton arrangement is that the attachment of muscles and other organs is simplified. Compared with the ant, you are poorly constructed. The least little bump may damage or destroy one of your delicate organs since it is not protected by armorplate, while a blow of similar magnitude, considering the difference in size, would scarcely be noticed by the ant. Of course, ants in the larval state are not protected by an outer skeleton; but they are guarded by watchful adults who wear natural suits of armor.

From the ant's mouth a gullet leads through the various divisions of the body to the large swollen abdominal section at the rear, where it joins a crop, which is a sac with elastic walls. Next there is a stomach, separated from the crop by a valve; and then the usual intestines and other digestive equipment. Liquids swallowed by the ant enter the crop, and a small portion of the total amount taken in passes through the valve into the stomach. The remainder stays in the crop. The ant is able to force quantities of the crop contents out through its mouth, for the purpose of feeding other ants of the colony.

Thus the ant is equipped with a natural storage bin or tank for food. Observers report that certain ants are given the job of obtaining food for the entire colony. These ants sally forth on their errands, fill their crops with liquid food, return to the nest, and distribute it among the other inhabitants by the process of regurgitation. You can watch the crop-filling action

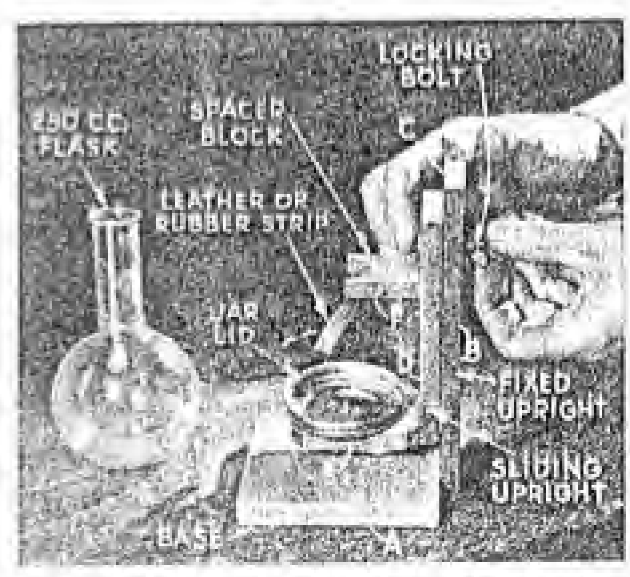


Illustration showing how the wooden holder for the flask of colored water is assembled. A bolt with winged nut makes it possible to adjust the flask at any height or angle required

by feeding a pale-colored worker some syrup dyed with one of your microscopic stains.

When some of the food is given to other workers, their insides become colored too.

TO EXAMINE the crop and other organs with your microscope, remove the bulb-like rear portion of the body, place it in water on a hollow-ground slide, and tear it apart with dissecting needles. You may have to dismember several ants before you get suitable specimens. You will note, among other things, the spiral-walled air tubes with which the ant breathes.

At a magnification of about 100 diameters, you will find many interesting things to study in and on the ant. You will discover, for one thing, that its shiny armor plate is not as smooth-surfaced as it appeared when viewed with lower powers. The surface of one of the abdominal segments, for instance, is seen to be delicately pebbled, like fine leather. Then you will find numerous hairs, or spines, protruding from the surface. Some of these hairs are much larger than the others, and present a peculiarly notched or jointed appearance.

To obtain a specimen of the ant's outside skeleton, suitable for examination at high powers, tear apart an abdominal section as directed, and then separate one of the segments. With dissecting needles, carefully scrape away all unwanted material, press the concave side against a slide, add a drop of water and lay over it a clean cover glass. Tension of the water between the glass surfaces will press the specimen flat.

By all means capture one of the winged ants, for they contain wonders not to be found in the common workers. If you cannot find one of them crawling along the ground on a warm day, dig into an undetermined nest.

There are, you will find, two pairs of wings, the forward pair being the larger. With sharp-pointed tweezers, remove the wings and mount them in water beneath a cover glass. The wing surfaces, your microscope will reveal, are covered with innumerable tiny spines, or hairs. Examine carefully the front edge of one of the two smaller wings, those that were mounted on the ant's body to the rear of the larger pair. In orderly array along the edge, you will see a series of tiny hooks, curved all in the same direction, like a row of hooks on which the butcher hangs meat in his shop. These hooks look as if they were designed to engage something. Shift the slide until you have the rear edge of the front wing in the microscope field. Carefully move the focusing screw so that you can examine first the upper plane of the specimen and then planes at successively lower levels. You find that the wing edge is curved over to form a groove or channel, into which the hooks on the other wing section fit.

IF YOU have studied the honey bee microscopically, you will remember that it was fitted with a similar hooking arrangement. The purpose of this ingenious mechanism is to enable the insect that possesses it to hook its front and rear wings together so that they present a single surface to the air, and thus provide greater efficiency. When the wings are folded, the hooks automatically slip out of the groove. This mechanism is one of the outstanding wonders of the insect world.

Remove the rear half of a winged female ant's body and place it in a drop of water on a hollow-ground slide. With dissecting needles crush the piece and tear it apart. The water will take on a grayish, cloudy appearance. Without placing a cover glass over the water drop, transfer the slide to the microscope stage and examine it at fifty or more diameters. You will see tiny, oily droplets floating about over the surface of the water, the specimen looking for all the world like greasy water you have seen in a kitchen. These droplets of fat may serve as food during the nesting period.

A USEFUL gadget for the microscope table can be made from a glass bottle or flask and a few pieces of wood. The flask is filled with colored water and used as a light filter in front of the microscope mirror. The spherical shape of the flask causes the liquid to act as a condensing lens, concentrating the light into a small area. Laboratory workers who have to spend long hours at a microscope relieve eye strain by filling a flask of the type illustrated with a solution of copper sulphate in water, and placing it in front of an electric lamp. The copper-sulphate solution, being of a bluish color, gives to the light reaching the microscope a daylight quality that is not as tiring on the eyes as unfiltered artificial light.

To make the filtering device, the following materials are required:

Wood parts—

A—One 3/4-by 4-by-4 in. piece for base.

B, B—Two pieces 3/8 by 5/8 by 7 in. for fixed uprights.

C—One 3/8-by 3/4-by 1 1/2-in. piece for connecting tops of uprights.

D—One 3/8-by 1 5/8-by 5 1/2-in. piece for sliding upright.

E—One 3/8-by 2-by 2 3/4-in. piece for supporting flask.

F—One 3/8-by 1 1/8-by 1 1/2-in. spacer block.

In addition to the wood, the following are required:

One 250-cc round- or flat-bottomed flask, obtainable at laboratory supply houses or drug stores.

One metal jar lid 2 1/2 in. in diameter, to serve as a socket for the flask base.

Strip of soft leather or rubber 1/4 x 4 in.

One 1/8-or 3/16-in. stove bolt 1 1/4 in. long, equipped with wing nut and two washers.

About two dozen nails 1/2 in. long.

The support for the flask is composed of two parts. One, consisting of the square base and two uprights spaced so that there is a slot between them for receiving the stove bolt, serves as a stand for the movable flask holder. The flask rests in the jar lid which in turn is nailed to the projecting shelf at the bottom end of the sliding upright. The spacer block has its outer end cut to fit the neck of the flask, and is equipped with the rubber band or leather strip to hold the flask in place. Fasten one end of the band firmly with the small nails, and cut a slit near the other end so that it will slip over the projecting head of another nail or brass escutcheon pin. Drill a hole, to receive the stove bolt, about an inch from the top of the sliding upright.

Thus you have, when the parts are assembled, a flexible mounting that permits the flask to be moved up or down and swung forward or back, as light conditions and the position of the microscope mirror require.

In addition to the copper-sulphate solution, there are numerous other colored liquids you can use to control the quality of the light. By keeping on hand several bottles or flasks, filled and corked tightly, you can have a wide selection of inexpensive filters. Various aniline dyes and staining solutions can be pressed into service. Leave sufficient air at the tops of corked bottles to take up expansion caused by heating the liquids in them.

Turn the Microscope on Your Christmas Tree

Holiday Evergreens Will Introduce You To the Important Family of Plants Called Gymnosperms, and Furnish the Materials For Countless Hours of Fascinating Study

POPULAR SCIENCE MONTHLY JANUARY, 1937

By Morton C. Walling

THE holiday season brings into the spotlight the Christmas tree; the Christmas tree suggests others of the so-called evergreens, and that brings us to a fascinating subject for our microscopes. For in the plant family that goes by the name of gymnosperm, and which includes the spruces, firs, and other trees so popular at yuletide, there is an endless array of material for the microscope hobbyist—material which, in most localities, is readily available at any time of the year.

The gymnosperm family of trees can claim distinction for being one of the most ancient. The coal you burn contains abundant evidence that pines and other members of the family flourished in prehistoric times when the coal beds were being formed from dying vegetation. The word "gymnosperm" means "naked seeds." That is, the seeds of trees in this family are not formed in a pod or other protective structure. The naked-seed family contains the spruce, hemlock, pine, cedar, fir, redwood, cypress, yew, tamarack, juniper, arbor vitae, and other trees and plants commonly grouped together and called evergreens; and a number of plants which are not very commonly known, such as the tropical, fernlike cycads.

The common pine tree is probably the best-known member of the gymnosperm family, and it usually is employed as a specimen for studying the general characteristics of the group. You ought have no trouble obtaining adequate supplies of pine-tree or related material for microscopic examination. Even in your own parlor, at Christmas time, you can procure a few leaves (needles), some small branches, and perhaps a few cones; and almost anywhere you can pick up blocks of pine wood which can be converted into

specimens revealing greater beauty than you ever imagined could exist in a piece of wood.

Briefly, the life history of a pine tree is as follows: The plant you know as a tree is a sporophyte, whose job is to produce spores; and these spores are developed in structures known as sporophylls.

A young cone being sliced free-hand with a scalpel. A piece of soft wood makes a handy little chopping block

Left, dehydrating a small plant specimen with ethylene glycol mono-ethyl. This liquid, sold as a cleansing solvent, is used by some observers instead of alcohol

The sporophylls of the pine are specialized leaves collected into groups commonly known as cones. They appear in late spring. There are two kinds of them, as you will discover by examining a pine tree carefully. The staminate, or stamen-producing, cones composed of microsporophylls are the smaller. Each scalelike leaf contains two spore-producing chambers. These develop spores, or pollen, in such abundance that, in a pine forest, it may rain down like golden snow. The pine, being a primitive plant, depends largely upon vast numbers of spores to carry on its life chain.

The megasporophylls group together into larger cones; and it is these that most people recognize as pine cones. They are sometimes called carpellate cones. On the upper surface of each of the leaflike megasporophylls are two megaspores. Communicating with the interior of the structure containing the megaspores is a slender passage, the micropyle. When the golden spores from the microsporophylls fall on the megasporophylls, some of them enter the slender passage, where fertilization takes place.

Under the microscope, a grain of pollen from the pine tree reveals itself as a tiny structure with two wings. The wings really are tiny air sacs that enable the pollen grain to travel long distances on the wind.

If you wish to make a permanent slide of some pollen grains, let them remain in a cardboard box, or in a bottle with a cloth stretched over its mouth, until dry. Then put the pollen into a small amount of turpentine in a test tube or vial. Several days may be required for the turpentine to replace the air in the grains. When this has been done, clean a cover glass, put a small amount of balsam in its center, and transfer the pollen to it after excess turpentine has been drained off. The pollen should be arranged in a thin layer. After the balsam has hardened on the cover glass, drop a little balsam in the center of a one by three-inch slide and, if necessary, warm it or add a trace of xylol to thin it; then carefully lower the cover glass carrying the pollen, balsam side down, on the slide. By gentle pressure, force out any air bubbles that you may have trapped. You can mount pine seeds in a similar manner.

The staminate and carpellate cones of the pine or other gymnosperms can be examined by splitting them down the center with a knife and examining at magnifications up to fifty diameters. Presence of much resin sometimes makes it difficult to do the splitting, but a bit of xylol will keep the blade lubricated. Remove a single scale or leaf from one of the smaller staminate cones, and examine it. Note the elongated pollen sacs on its lower surface. By opening these sacs when the pollen is about ripe, you can obtain supplies of grains. On the scales of the larger carpellate cones, you can observe the two ovules.

Leaves of gymnosperms resemble needles or scales. A good example of the needle-type leaf is provided by the pine, and of the overlapping scale type, by the arbor vitæ used so widely as a decorative evergreen shrub. Leaves of gymnosperms are constructed to withstand dry soils and weather. That is largely the reason why pines are able to grow on hilltops, mountain sides, and other places where there is relatively little moisture. Examine a cluster of pine needles. Note how slender and thick-bodied they are, how close they are together, and how they usually point upward where the sun will not strike them squarely. All these are precautions against too rapid loss of moisture.

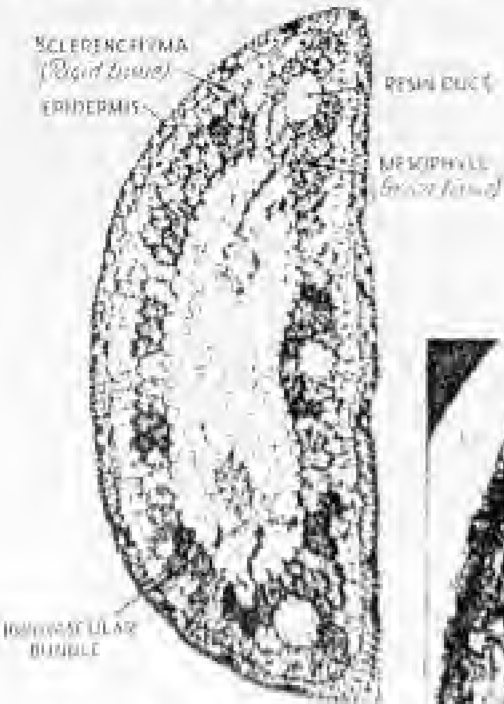
In examining a whole pine needle at low power—twenty diameters or so—you will observe that it carries rows of glasslike spines along its edges, with their points turned toward the tip. You can feel these spines by pulling the leaf between your fingers. You can see also the stomata, or breathing pores, in lengthwise grooves, this arrangement being a further provision against moisture loss.

Satisfactory sections of a pine needle can be cut free-hand by holding it between two pieces of elder pith, potato, apple, or carrot. Hold the blade of the razor—and it must be a perfectly sharp blade—in a horizontal position so you can draw it toward you, across the pine needle. Place a little water on the upper surface of the blade, so that the sections, when cut, will float in it. Use a straight razor or a safety-razor blade in a suitable handle.

Here a yew leaf, held between the halves of a split carrot, is being sectioned with a razor. A little water is placed on the upper surface of the blade to float the sections

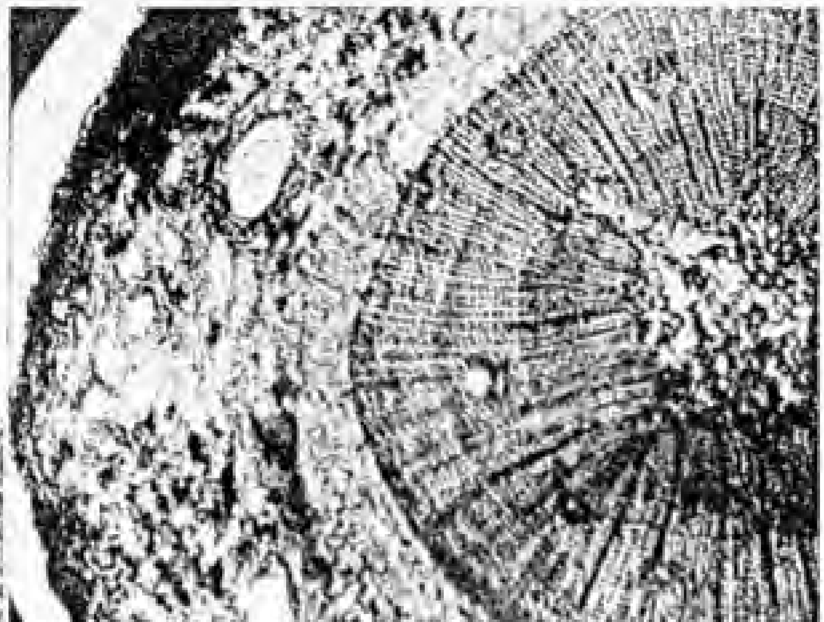
In a cross section of the leaf you can note the following features: The thick skin, or epidermis, designed to retard moisture loss; directly beneath it, the sclerenchyma, or rigid tissue; next, a wide band of green cells with infolded walls, and with resin ducts among them. These ducts are large, and open at the center. In the center of the leaf is a region of cells, mostly empty, with usually two fibrovascular bundles near the center of each half of the region. Some of the cells contain protoplasm. This part of the leaf resembles somewhat the wood of the pine stem, and you can see elementary medullary rays. If you are lucky enough to slice one of the breathing pores in the middle, you can see the air chamber in the green tissue, and the two green guard cells below the epidermis, flanking the opening.

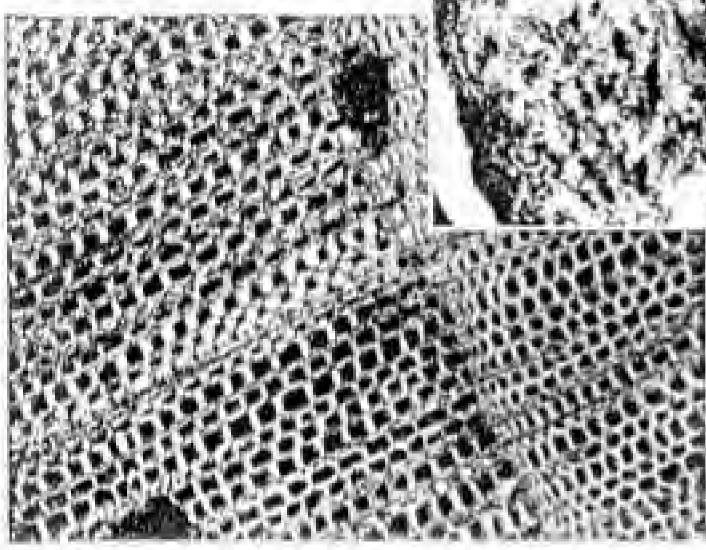
ALTHOUGH, because of the season or other circumstances, you may not be able to obtain suitable specimens of cones and spores, you most certainly can procure a twig or two from the nearest Christmas tree, and some pieces of pine wood from an old pack-



ing case or the scrap pile of a woodworking shop. Many microscopists find the wood the most fascinating part of gymnosperms to study.

It is not a difficult trick to slice a twig one eighth inch or so in diameter into sections thin enough for microscopic examination. The only tool you need is a sharp razor. Usually, the slicing can be done easier if the twig is rested on a piece of cork, a soft-wood block, or a





PINE LEAF, TWIG, AND WOOD AS SEEN BY THE MICROSCOPE

At the upper left is a magnified cross section of a pine leaf, or needle, showing its various parts. Above, a cross section of a twig, cut free-hand like the one on the opposite page. At the left is a cross section of pine wood as seen by polarized light. Note the alternate layers of thin-walled and thick-walled cells

SELECTING A SPECIMEN

Stems, leaves, and sometimes cones can be snipped off decorative evergreen shrubs, for use as specimen material for microscope examination

sheet of cardboard. Guide the razor with the forefinger of the hand with which you grasp the twig, and cut the sections as thin as possible. For ordinary examination, the sections can be placed in water. A water-glycerin mixture, or pure glycerin, will preserve the sections for a long time under a cover glass. For permanent mounts, the sections must be fixed, stained, and mounted in balsam. Stem sections usually can be fixed by placing them for an hour in absolute alcohol. They can be stained in alcohol-, water-, or oil-soluble dyes; or even with commercial wood stains, and mounted in balsam. Tangential sections of stems can be made simply by whittling the wood with a razor so as to produce chips as thin as possible.

An ordinary block plane or small smoothing plane such as carpenters use will serve as a microtome for making sections of pine wood. First, sharpen the blade on an oilstone and hone it on a razor hone until it has a razor-sharp edge. Adjust it until it barely cuts a shaving. Clamp a block of pine wood in a vise or hold it in your hand, and plane it until you have a little pile of thin shavings from which to select specimens suitable for mounting. The wood can be stained and mounted in the manner described for stems. Be careful to eliminate air from the cells. One way of doing this is to soak the sections for a few hours in turpentine before transferring them to the balsam.

IN A small stem cut in cross section, you can observe at twenty diameters or so the outer bark, green in places, made of large cells; a layer of fibrous bast cells beneath the bark, and then the cambium layer of living tissue, from whose cells growth progresses. Next are the rings of wood cells, and in the center is a small region of pith cells. In the wood and outer bark you can observe the large, open resin ducts. Radiating from the center like spokes of a wheel, are the medullary rays that act like crosswise city water lines connecting main trunk lines.

The wood of pine trees is composed almost entirely of long, slender tubes, ingeniously grouped together to give strength and to facilitate the life processes of the tree. These tubes, called tracheid cells, react to conditions affecting the tree at the time of its growth. When the weather is cold and the rainfall light, the cells are not able to grow much, if at all, and therefore are small in size. When the weather is warm and there is plenty of rain, the cells grow rapidly and to large sizes.

Therefore you can read, in the cross section of a bit of pine wood, something of the history of the tree from which it came. You find, on examining this section with your microscope, that there are abrupt boundaries between groups of cells. Large cells with thin walls extend in a slightly curved line across the field. Several rows over, the cells begin to become smaller, and their walls thicken; until finally the walls are very thick and the spaces between them barely visible.

THE story told by these cells of different sizes is this: In the spring, the tree has to have lots of food-carrying water coursing through its veins (the tracheids), so that it can grow. The spring rains provide the water, and the spreading of cell material into thin walls provides the necessary space for the water to flow through the tree. As the season advances into summer and approaches autumn, the water supply becomes less, growth slows down, and smaller cells with thicker walls are produced. Finally, as fall progresses

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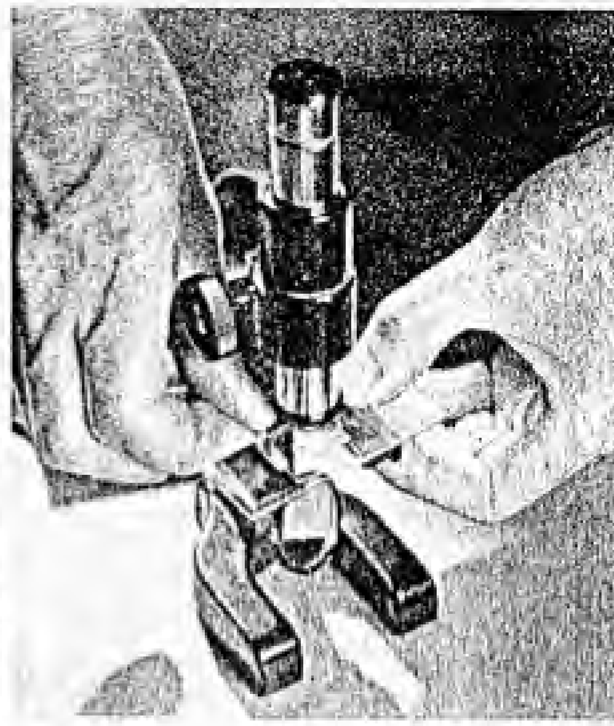
Finding New Wonders in Shavings

The photographs below and at the right show how longitudinal sections of wood can be cut with a sharp block plane, clipped from the shavings in sizes to fit under the cover glass, and placed in the microscope. Such specimens may be examined dry. By adjusting the clips to press on the cover glass, as shown, you can hold the sections flat



into winter, growth becomes still slower, and eventually ceases; and the cells accordingly grow smaller and thicker-walled. Growth is resumed abruptly in the spring. Thus are formed the annular rings, which give wood much of its beauty and enable scientists to tell very closely the ages of trees. Things affecting the formation of cells, such as forest fires or drought years, make their presence known to the wood experts and his microscope.

Running through the groups of cells, roughly at right angles to the annular rings, are streaks of long, slender cells whose sides are visible in cross sections of wood. These are the medullary rays. Here and there among the tracheids you will observe large openings bordered by a few cells of slightly different form. These are the resin ducts that are typical of pine.

When you plane a pine board parallel to the grain, you generally are cutting tangential sections of the ducts. Examination of a thin shaving will reveal more wonders of pine wood. The tracheids, which are not exactly like the cells which botanists call tracheids in deciduous trees, are seen to be not endless tubes, but cells whose ends taper down to a blunt point, and which are fitted together in a most ingenious fashion.

LOOK carefully at the line separating the end of one tracheid from the end of the adjacent one, and you may be able to see the bordered pits, or automatic valves, which regulated the flow of sap from one cell to the next when the wood was alive. If the blade used to cut the section has grazed the end of one of the cells, the pits may be seen as circular formations resembling tiny washers laid side by side.

A radial section of a pine stem is one cut parallel to a line passing through the center of the stem—parallel to the radiating medullary rays. Such a section often will reveal more clearly the bordered pits in the tracheid cells, and also will show, in longitudinal section, the cells forming the medullary rays.

The microscope frequently throws new light upon some important historical fact or condition. This is illustrated beautifully by examining a tangential section of yew wood (Canadian or Japanese yew, or *Taxus*). You will observe that each of the long, slender cells has inside it a spiral, springlike thread. Sometimes these coil-spring structures can be seen more clearly by examining the edge of the specimen, where the cells have been torn in cutting.

Now, it was known to the ancient archers that yew wood is more springy than most woods; and therefore it was used to make bows for shooting arrows. This springy quality, so important to the arrow-shooting hunter or warrior, results from the spiral threads in the cells of the yew. These springs prevent the collapse and breakage of the cells when they are bent, and cause them to return to their former positions. Modern man has taken a lesson from the yew, and employs coil springs to enable him to bend lead pipes without flattening them, and to construct noncollapsible, flexible hose.

WAYS of sectioning, staining, mounting, and otherwise handling botanical materials of the type we have been discussing are almost endless in number. Every professional microscopist has his own pet methods and materials. However, a brief outline of some of the things that can be done may be of help in the preparation of specimens, particularly those for permanent keeping.

Before sectioning leaves, young stems, roots, and other parts which might be crushed by the knife blade, it is necessary to fix or harden them. Simply leaving the specimens in ninety-percent alcohol for a week or so generally is satisfactory. Change the alcohol every day for the first three or four days. Absolute alcohol can be used for very small objects.

A popular general fixing agent is made by mixing seven ounces of one-percent chromic acid, twenty-four drops of glacial acetic acid, and three ounces of distilled water.

Fix the specimen for about twelve hours, then wash it well with water before dehydrating.

After fixing, pieces of roots, leaves, and so on can be preserved in eighty-five percent alcohol, or in a mixture of equal parts of water, glycerin, and alcohol. If the glycerin solution is used, the specimens must be dehydrated before embedding in paraffin.

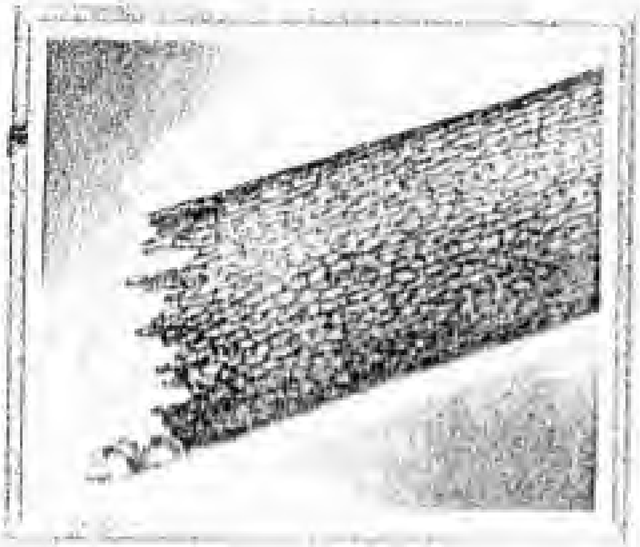
The number of stains that can be used for darkening cell walls and for bringing out certain details is almost limitless (P.S.M., Apr. '36, p. 41). Staining sections after they have been cut and mounted on the slide is preferred by many botanists to immersing the bulk specimens in the stain.

DEHYDRATION usually is accomplished by passing the specimen successively through alcohols of increasing strength, ending with absolute. Some microscopists have had success with ethylene glycol mono-ethyl ether as a dehydrating agent instead of alcohol. This liquid, which looks like water, is sold commercially as a cleansing solvent for about $1.50 a gallon. It will dissolve xylol, alcohol, balsam, turpentine, and water. One way of using it in making permanent slides of plant material is as follows: Stain the specimen in any manner desired. Remove it from the stain, put it in the cleaning liquid for thirty seconds, and then transfer to Canada balsam for mounting. To dehydrate fresh-cut material completely, place it in the solvent for a minute or so, stain in an alcoholic solution, transfer to clove oil for clearing, and then mount in balsam. The possibilities of this new solvent have not been thoroughly explored, and further uses for it may be discovered.

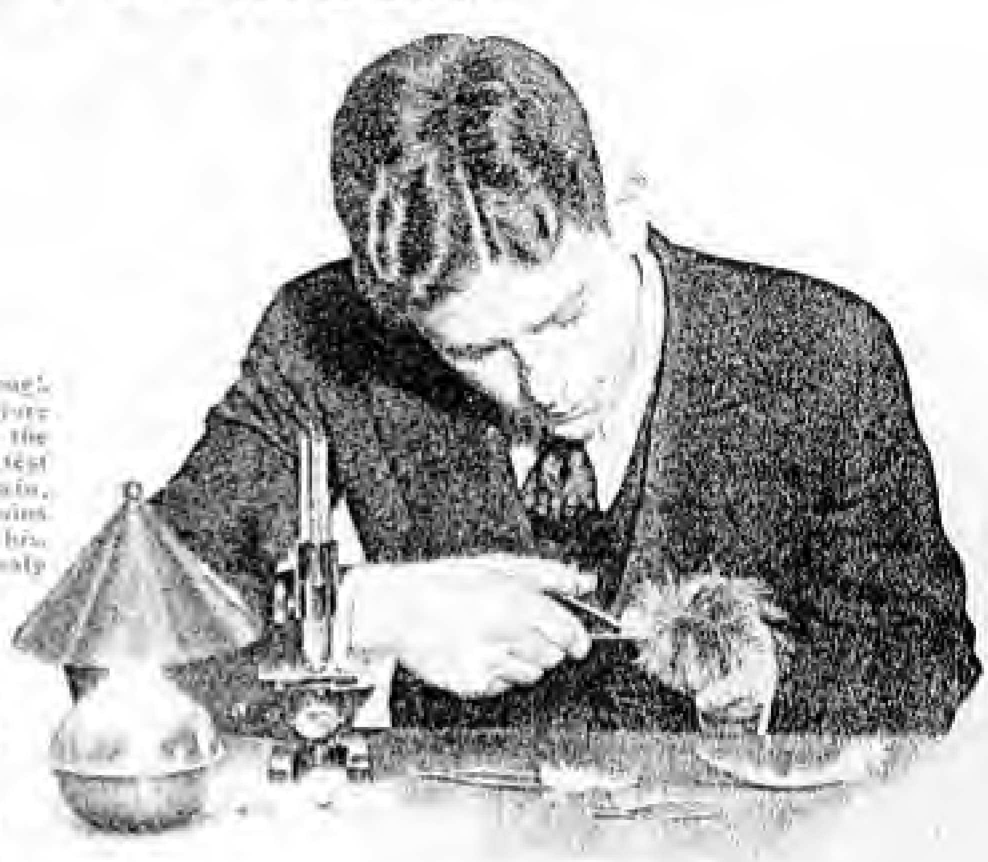
Your Microscope Reveals Secrets of HAIR AND FEATHERS

By MORTON C. WALLING

POPULAR SCIENCE MONTHLY
JUNE, 1935



Left, the rough cellular structure of a barb at the point of greatest physical strain, just where it joins the stalk, or rachis. It appears scaly



YOUR microscope will demonstrate that anyone, unless totally bald, can boast a permanent wave; and that bird feathers are efficient living structures largely because of the presence of tiny hooks.

The hair on your head and body corresponds to the feathers of birds and the scales of reptiles. Probably you think of it as a collection of simple strands, in themselves not very interesting. But a little exploring with your microscope will reveal that your hair is somewhat more complicated in structure than you supposed.

Cut a half-inch section from a hair and place it on a glass slide. Look at it at 100 diameters, or, better still, 500 diameters. You see a rod, apparently one third of an inch to one and one-half inches in diameter. The rod is translucent; it looks brownish by the transmitted light. Focus the microscope slowly. At one point the the upper surface of the hair will be sharply defined; at another position, the edges will appear clean-cut. The surface, you perceive by this focusing, is marked by a great many fine, wavy lines running roughly, crosswise of the hair. Thus, you see, the hair carries a permanent wave, for these markings are characteristic of human hairs.

Criminologists have attempted to use these waves as bases for identification and classification of hairs, to identify the person or body from which a certain hair came. Some experts claim that hairs themselves do not provide reliable means of identifying persons or races. On the other hand, it was reported not long ago that a microscopist had found a way of telling with fair accuracy the age of the person from whom a hair came, just by studying the spacing of the wavy lines.

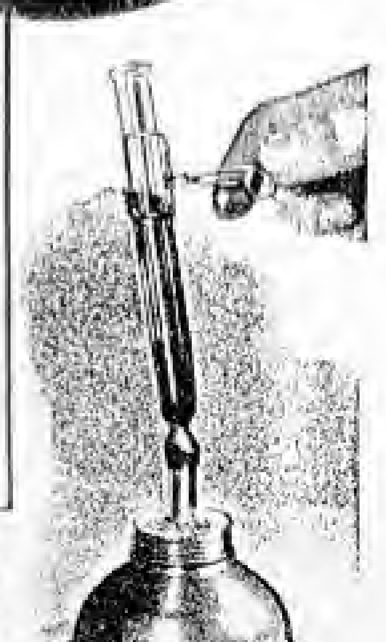
If you wash a hair in ether to remove the oil, and then mount it in Canada balsam under a cover glass, you will not see the surface markings as readily as when you examine it in air. Instead, the hair will seem to be more nearly transparent, and to show streaks running lengthwise, as if it were made up of parallel strips of some material.

Is the hair constructed like a cable instead of a rod? Let us explore this possibility. A look at the cross section of a hair ought to show something. But how can one make a good cross section of so small an object? One way is to bundle a great many hairs together until they form a little rod, and dip them into thin glue or paste. Let the adhesive dry, and then slice the resulting bundle crosswise with a razor, holding it either against a piece of cork or in a microtome.

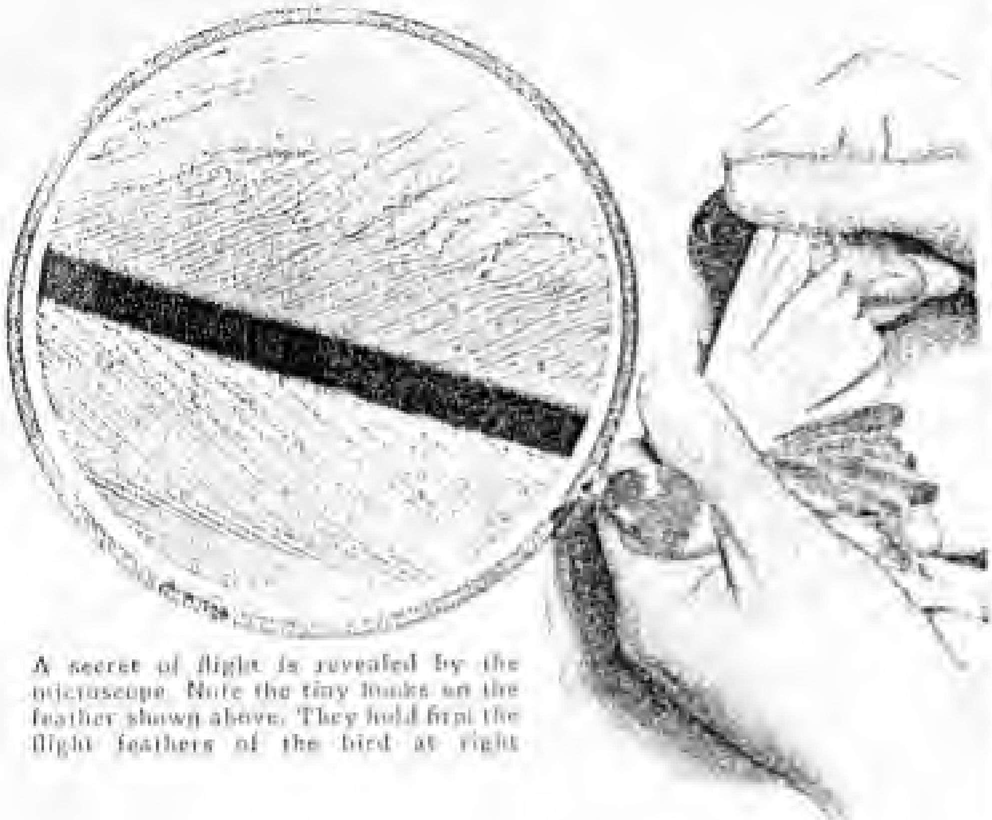
In shaving, you can produce a supply of cross sections of your beard without trouble. First shave in the ordinary way. Then, while holding the skin taut so that the beard stands up, and without using soap or shaving cream, go over your face again with a perfectly clean razor. Transfer to a glass slide the scrapings which collect on the blade. Examine them with your microscope, and you will find numerous irregu-

HUMAN HAIR MAGNIFIED 250 TIMES

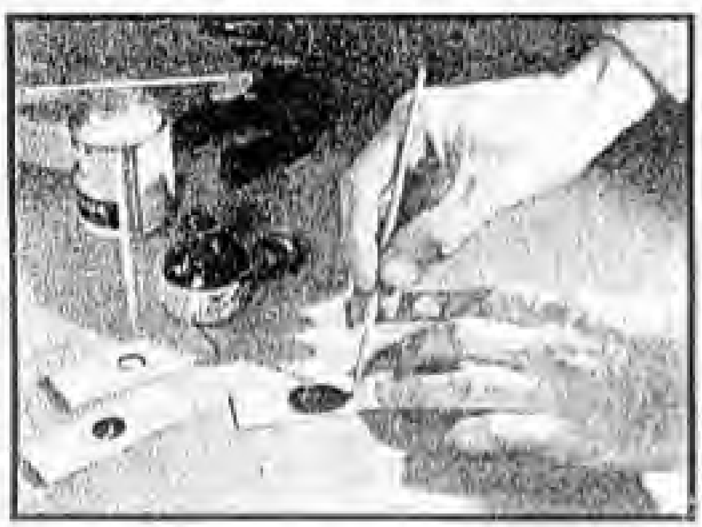
Not a tree trunk, but a human hair under high power lenses, the specimen at right shows a peculiar wavy surface resembling bark or rough skin



Above, the long, tenuous cells of which hair is made. To see these, you must first heat the hair in sulphuric acid, as at right, to "break it down" to basic structure



A secret of flight is revealed by the microscope. Note the tiny hooks on the feather shown above. They hold firm the flight feathers of the bird at right



MOUNTING SPECIMENS ON HOMEMADE SLIDES

Making special slides out of wood and cardboard, for dry-mounting. Black India ink is used to darken surface under specimen. Left, parts of slide

lar pieces of hair. Some of these will have been sliced more or less crosswise, so that you can see the hair structure. Most of the particles will be of odd shapes, as a result of being cut at different angles by the razor.

Examination of one of these cross sections reveals that the hair is made up of an outward bark or shell,—the wavy layer you first saw—enclosing a great many pieces arranged like sticks in a bundle. Near the center is an area that looks dark, as if it were filled with pigment. It is, however, not pigmented, but contains air which, under certain conditions of illumination, looks solid. This is the pith, or medullary region. With dark-field illumination, the openness of this center area is shown better.

But these examinations do not tell you the whole story about the hair. Place a hair in fairly strong sulphuric acid and heat it carefully. It is not necessary to let the acid boil. After the hair has been in the hot bath a few minutes, transfer it to a drop of clean water on a microscope slide, and apply the cover glass. If you now look at the hair, and if the acid has acted properly, you will see that the surface is covered by irregular patches of thin material which seems to be peeling off, like the skin from a snake that is shedding. This thin layer was the one that contained the characteristic wavy markings.

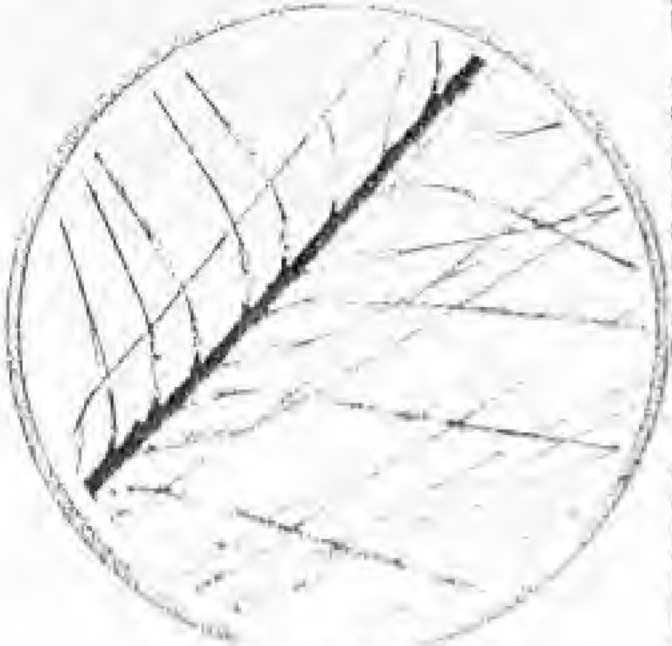
Now, with a pencil or other instrument, gently press the cover glass against the slide. The pressure will cause the acid-softened hair to break down and separate. At last you see the true nature of the hair. It is made up of a bundle of long, slender cells, perhaps the thinnest cells to be found anywhere in the body. They are angular in cross section, because of the pressure with which they were compacted. Careful examination of the soft, bulbous base of a hair reveals that the cells there are wider than in the main portion of the hair. As the hair grows out of its follicle in the skin, the cells shrink in size, and group together to form a compact bundle. It's much the same structure as would result if a bundle of rubber bands were forced lengthwise through a small opening, and wrapped with a few layers of a tough, transparent skin, as they emerged.

Examine the hairs of mice, cats, dogs, and sheep. You will see, for instance, that sheep wool has coarse surface markings; that it actually is rough-surfaced, like a file. This roughness is a valuable property of wool, because it makes possible the felting action whereby each strand becomes firmly interlocked with those surrounding it so that wool is much stronger than most cloth produced from smoother fibers.

One good source of hog bristles or of similar hairs is an old brush. By shaving thin layers from the wooden back of a brush, at a point where a bundle of bristles is embedded, you can produce excellent cross sections of the hairs. You will find that a hog bristle is not covered with a separate bark, as was the human hair. Instead, it seems to be nothing but a bundle of small fibers, with an open space in the center, surrounded by air-filled cells.

The microscopic examination of hairs is more than a mere pastime in certain branches of biology and allied sciences. An expert microscopist familiar with hairs, very often can identify definitely a piece of animal skin. Properly preserved remnants of prehistoric animals can be recognized by examination of the hair structure. Government food experts are skilled at identifying hairs of mice and of other small animals in butter, and in other food products.

A feather, strange as it may seem, is essentially a bird hair. That is, it does much the same



Above, the barb of a down feather, magnified about 770 times. It is widely spaced because it is not important for flight

thing for the bird that hair and wool do for an animal. However, because a bird is an aerial traveler, the feather must be equipped for the more specialized work of flying. There are, on birds, three general types of feathers; namely, filoplumes, down feathers, and contour feathers. Of these, the contour feathers are most complicated.

THE larger end of the central stem of a feather is the quill or calamus. This part is hollow and partly transparent. The quill, as you proceed from the body end outward, becomes the shaft or rachis (at the distal end) of the feather vane. It is this vane that will be of greatest interest to the microscopist.

With dissecting shears, clip off some of the barbs extending outward in parallel lines from the shaft. Pull these barbs apart—note that it requires comparatively great force to do so—and examine one of them with your microscope. Note how the central part of the barb, made up of a great many oval cells at its larger end, narrows out until it becomes little more than a line of single cells, placed end to end.

By stopping down the substage condenser, you can see that the big end of this central portion is surrounded by a transparent shell, along one side of which is a line of fine strands. Farther along, these strands become larger, and a similar line appears on the opposite side. These strands are the barbules. Examine carefully the barbules on each side. Note that toward their ends the structure changes. Many of the barbules along one side of the barb seem to be notched, or provided with tiny barbicels. These along the other side are similarly equipped, but many of the barbicels are bent back into distinct hooks.

In these hooks is the secret of the bird's power of flight. Each tiny hook, by catching a projection on one of the barbules of the neighboring barb, helps make the row of barbs function like a single sheet of material. Consequently, the microscope reveals a bird contour feather to be made up of a great many smaller feathers united by countless hooks into one light-weight, efficient, aerodynamic structure. You will not find these same hooks on the down feathers, which keep the bird warm, and do not beat the air or present a smooth surface to the air.

The highly colored feathers of the peacock and other bright-hued birds make beautiful microscope objects for low-power examination. But you will find all body feathers to be in general the same. That is, they will have central stems flanked by two rows of parallel barbs. Each barb will be found to be equipped with barbules and these, in turn, with barbicels, many of which end in tiny hooks. Most downy feathers, which give the bird a heat-insulating layer that builders of houses are beginning to imitate, are seen to be very loosely constructed. They are made up essentially of barbs provided with barbules which are not very close together. The barbules are sometimes ribbonlike where they join the barb. Farther out, they appear jointed, very much like jointed plant stems. At the joints, small pointed projections may occur.

IN ALL, you will find the subject of hairs and feathers engrossing. They are not difficult to mount or to observe. Permanent slides are easily made by clipping off bits of feather barbs or hairs and mounting them in Canada balsam. First, remove all oil, by rinsing the specimens in ether; and then saturate them with xylene to make sure that they will be completely covered by the balsam. Make a few dry mounts by spinning a shellac ring on a slide, coating the bottom of the cell thus formed with a very thin layer of balsam thinned with xylol, and then carefully laying the grease-free specimen in position so that the balsam touches only the underside. Let the balsam set, before applying the cover glass. A thin layer of shellac applied freshly to the ring will hold the cover glass in place. It is a good idea to apply a finishing touch by ringing the cover glass with asphalt varnish, gold size, or even ordinary four-hour enamel.

Did you ever hear of wooden microscope slides? They were in common use in England years ago, and are still useful today for opaque specimens. Samples of metal polished to show the grain structure, bits of wood, feathers, small shells, insect parts and other objects that can be viewed against a dark background, with illumination from above, can be preserved on wooden slides. Such slides are more durable than glass, and can be tied into compact bundles for storing or carrying.

MAHOGANY, walnut, thin plywood and similar materials can be used for the slides. The wood should be well seasoned. Various thicknesses will be desired, because the slide should be but slightly thicker than the specimen. After the wood has been sanded smooth on both surfaces, cut it into one- by three-inch strips, for the standard slide size. Mark the exact center of each piece and, with a sharp wood-boring bit, or a jeweler's saw, cut a circular opening all the way through the wood.

With sandpaper, remove splinters. To one side of the slide glue a one- by three-inch piece of cardboard which has been blackened in the center with India ink. The ink can be applied after the cardboard is glued in place. Sometimes it may be desirable not to blacken the cardboard. You now have a one- by three-inch wood-and-cardboard slide with a hollow depression or cell in which to mount the specimen. A bit of balsam spread on the bottom of the cavity will hold the specimen in place. When you have applied a label, your slide will be complete. It is not necessary to cover the cell with a cover glass, although you can do so, if you wish. The glass can be cemented in place with balsam, or held by a piece of gummed paper, with an opening in its center the size of the cell.

From ordinary snap clothespins, you can make various useful devices for handling slides and performing other operations in connection with your fascinating microscope explorations. For example, a suitably altered clothespin which does not have a very strong spring will serve nicely as a clamp for holding cover glasses in position while the balsam hardens.

THE altering consists for the most part in whittling the two wooden jaws so that they come together exactly parallel. Cut the wood away from the surface of one of the jaws to a depth about two-thirds the thickness of the slides to be used. If the pressure is too great, take the clothespin apart and bend the spring so that it is a bit less stiff. Too much pressure may crack the cover glass.

This transformation of commonplace snap clothespins into useful laboratory tools can be extended to an almost unlimited degree. A number of cover-glass clamps, and three or four clamps for holding warm slides will be found useful. It is possible to make an efficient test-tube holder from one of the clothespins, by rounding out the jaws so that they will fit snugly around the glass, and by reducing the strength of the spring if necessary. The clothespins can be waterproofed by boiling the wood in paraffin, or applying paint or quick-drying lacquer. Lacquer is best.

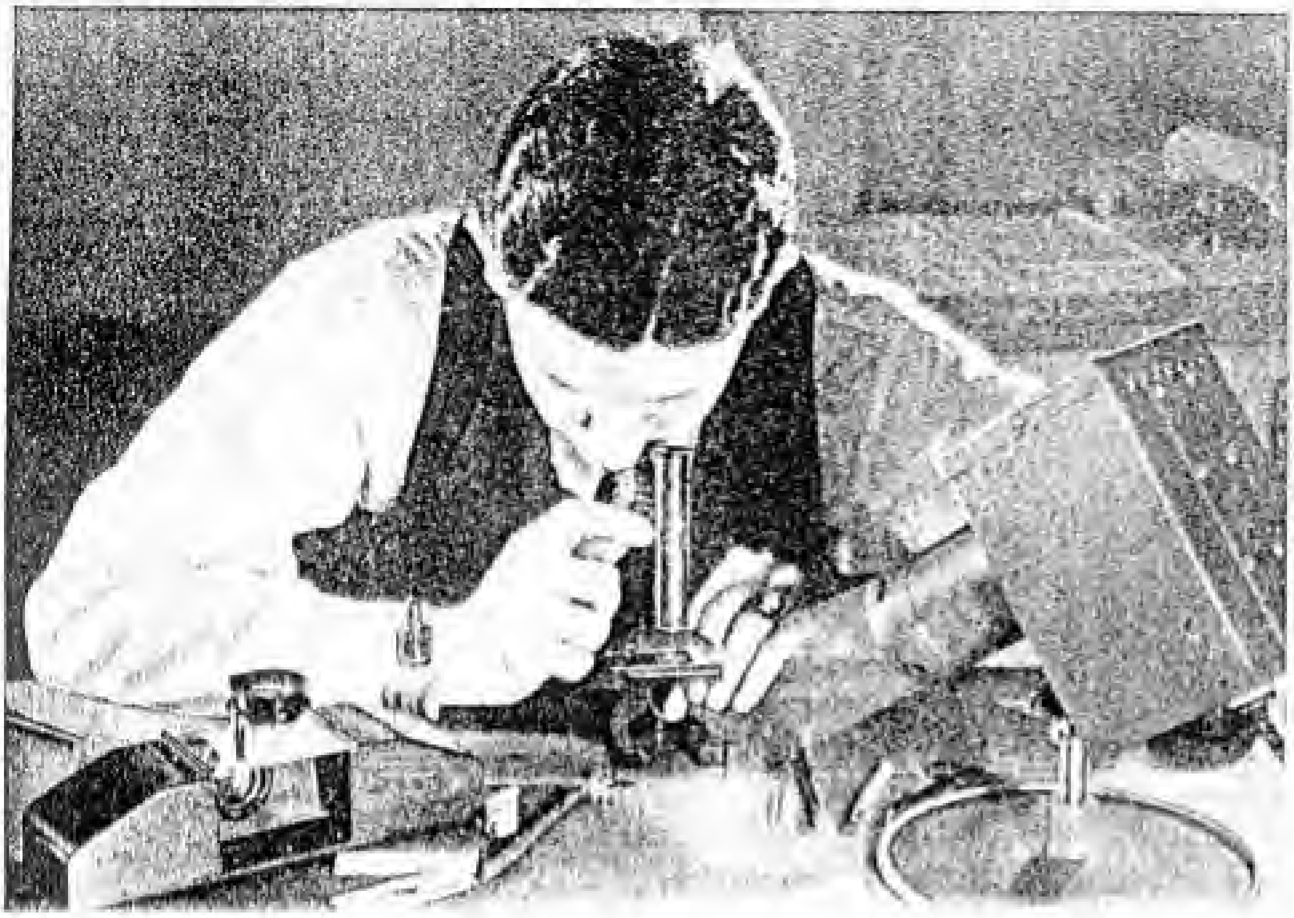
Insect Hairs
PROVIDE INTERESTING SPECIMENS FOR YOUR MICROSCOPE

By MORTON C. WALLING

POPULAR SCIENCE MONTHLY
OCTOBER, 1937

FROM fuzzy caterpillars to sleek mosquitoes, insects are equipped with hair of almost every imaginable form. Hairs decorated with knobs and spines, hairs with other hairs growing from them, hairs that look like fancy spears, and scales of marvelously beautiful form and color all can be found on common insects with the aid of your microscope. The variety of hairs, and of scales (which are a form of hair), is so great that they provide ample material for study with every possible lens power, from the low magnifications of inexpensive instruments to the highest-power laboratory objectives.

Some insects have few, if any, hairs or scales, while others are completely covered with them. These growths vary in shape from flat, paddle-like scales to cylindrical hairs. Moths and butterflies are the outstanding scale-bearing insects. Their scales are real works of art, with both brilliant hues



The beauty and variety of insect hairs will amaze you as you study them under your microscope

The tongue of a honeybee with its hairy coating. The elaborate hairs in the lower circle were taken from a beetle grub

and pastel colors. Most of the scales are found on the transparent, membranous wings, where they are attached to both surfaces by means of short stems. They lie in overlapping rows much like the shingles on a roof. Scales of different colors are grouped to form the distinctive markings.

The color of scales seems to come from two sources. Some scales contain a pigment between the two membranous layers of which they are formed, while others apparently are constructed so that their color is an optical effect resulting from the breaking up of light by fine corrugations on their surface, or by the thinness of the membrane, which acts like the thin film of a soap bubble. Butterflies and moths have scales containing color pigment, while members of the beetle family have the iridescent, metallic scales whose color is produced optically.

Scales of different shapes may be found on the same insect wing. For example, on the edge of a mosquito wing, you can observe long, somewhat slender scales having pointed tips intermixed with blunt, stubby ones. Each scale is provided with a stem, by which it is attached to a tiny socket in the surface of the insect's wing, leg, or body. Thus the scale resembles a leaf. The comparison goes even further, too, for like the leaf, the typical insect scale is composed of two membranes lying close together. Although it is essentially a hair, its structure suggests that it is an empty cell whose sides have been pressed together. In fact, some insects have scales that are expanded, like a paper bag blown full of air.

The things that make insect scales of particular interest to the microscopist are the surface markings, called ribs and striations, which can be seen on most of them. Generally the markings consist of ribs running parallel to each other. Sometimes there are connecting cross ribs. Some scales have parallel ribs on one surface, and ribs that diverge from a common point on the other surface.

When these surface markings are so arranged that they cause interference of light waves, the microscopist may see things that actually do not exist. Thus he may observe what seem to be rows of tiny knobs, where actually there are no knobs at all. A wing scale from the gnat or mosquito can be used as an example. The scale consists of a double membrane, on the surfaces of which are parallel rows of stiff ribs. At their ends, these ribs project beyond the edge of the membrane and form bristles or spines. On each side of the scale are fine markings, at right angles to the ribs. Between the ribs can be seen, with a good lens, parallel rows of beads. Microscopists for a time considered these beads as part of the scale structure. Then some one noticed that they seem to extend into space beyond the edges of the scale, and that by varying the angle of illumination, the number of rows of beads between any two ribs on a single scale could be made to vary; two, three, four, or more being produced at will. This led to the conclusion that the beads are not beads at all, but patterns formed by light interference between the ribs and transverse lines.

Insect scales also form valuable test objects for microscope lenses. The clearness with which they can be seen through a given lens depends on the maximum lens aperture that can be used without letting spherical and chromatic aberration interfere too much. Thus, by looking at a podura scale, taken from an insect called a springtail, which is found around decaying wood and in wine cellars, or at the scale from a butterfly or other insect, you can judge the performance of your lenses by the degree of clearness with which the image is rendered.

Scales are considered as being modified hairs, but in between the conventional hair of cylindrical form and the typical scale are a great many other forms. There are hairs or spines that resemble flat bayonet blades. Others

have fancy appendages and tips that make them look like medieval spears. The larva of an insect (Dermestes) that is found in museums, where it causes trouble by eating dried skins and furs, has a particularly elaborate hair. It is decorated along its shaft by whorls of spines, and near the tip is a cluster of considerably larger spines, surmounted by a set of about six hinged ribs which somewhat resemble the skeleton of an uncovered, partly-folded umbrella. On the legs of spiders, honeybees, and a great many other creatures, you can find hairs that are branched—hairs on other hairs.

While hairs probably provide general body protection, frequently they are developed into highly useful implements, as, for example, in the honeybee. Its head is covered largely with branched hairs, but along its legs the hairs are stiff spines. Projecting among the facets of the compound eyes are numerous hairs. Likewise, the bee's antennæ are hair-covered. It is probable that these antennæ hairs are connected with nerves, and that they help the bee to get around. Such hairs are called tactile hairs.

BECAUSE the bee's antennæ hairs become clogged with pollen as it works, thus dulling its sense of touch, it has on its first legs a set of antenna cleaners, concave combs with spinelike teeth. The same legs have pollen brushes composed of stiff hairs, which are used to handle collected pollen. Also there is a pair of eye brushes, used for cleaning pollen from the hairs surrounding and covering the compound eyes. Structures of special construction, composed largely of hairs or spines, are found on other legs. Each foot is provided with a battery of tactile hairs, sensitive to touch.

Other insects besides the bee frequently are equipped with hairs modified for special uses. The spider depends largely on the hairs of its legs and feet to keep it from slipping off the strands of its web. Doubtless, insects such as ants, which burrow through the earth, depend on sensitive hairs to guide them about. At any rate, the hair in some form or other is a highly important piece of insect equipment, and one that merits close attention.

Half the fun of exploring the insect world with the microscope is the making of permanent mounts of interesting specimens. You will, therefore, treasure a set of slides containing such objects as moth-wing scales, mosquito wings and legs showing scales, spider skins, ant skeletons, and bits of skin from insect larvæ that have hairs of unusual form.

If the insect is small, you can mount it whole. Then you can study its other features as well as its scales or hair. Insects that are small and soft, or their larvæ, can be mounted directly in pure glycerin, sealed under a cover glass with gold size or other sealing material. If you are interested only in the hairs or scales, you need not worry much about possible distortion of the body shape through improper handling or too rapid removal of water.

ANOTHER common way of mounting small insects such as lice and fleas is to drop them into strong carbolic acid, which removes water and clears them at the same time. Then transfer them directly to a drop of balsam on the slide. Some workers prefer to clear the specimens further by placing them in xylol for a time before transferring to balsam. Perhaps the simplest method of preparing small insect specimens is to drop them into turpentine for at least an hour, and then mount them in balsam. This method can be used with mosquitoes and similar specimens.

Clusters of hair from the bodies of woolly caterpillars and other larvæ, bits of butterfly and moth wings, and similar objects should be tested to determine whether they ought to be mounted dry or in balsam. Sometimes a balsam mount will suppress too much detail, while at other times it improves the detail. A simple test for determining which is better is to examine the specimen first

Making Thin Sections of Microscope Specimens

HERE is an easy way to cut thin sections of wood and other specimens without special equipment. All you need is a piece of sheet brass or other nonrusting metal about one-sixteenth or one-eighth inch thick; a very sharp safety-razor blade; some collodion, airplane-wing dope, or celluloid solution; and a jeweler's saw fitted with a blade that makes a cut of the same width as the specimen to be sectioned.

Make a saw cut in one edge of the metal to a depth of about three quarters of an inch, and hone both surfaces of the brass with a razor stone to remove burrs and smooth the area around the cut. Then clean out the notch with a thread.

Thin sections can be prepared by wedging specimen in slotted plate, as above, slicing with razor, and mounting in xylol

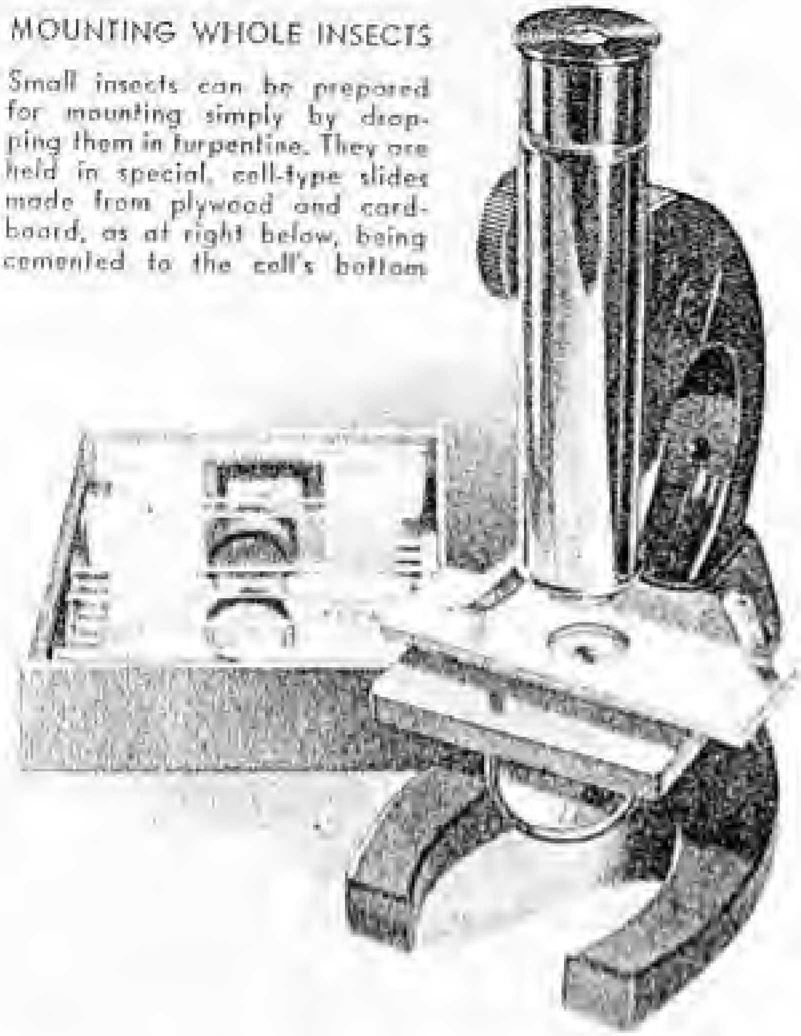
Photomicrograph of a thin wood section

Wedge the piece of wood in the slot so that one end projects above the top of the plate for a short distance, place a drop of collodion on this projecting end, and spread it out in a thin layer. When the collodion film dries, slice it off, along with the projecting bit of wood, by sliding the razor across the metal. Discard this first section.

Now move the wood so that the squared end projects above the metal to the thickness of the section you want—with a little practice, this is easy to judge. Again, apply the collodion, let it dry, and slice off the end. Transfer this section to a little pool of xylol on a clean glass slide, add a drop or two of balsam, and lower a cover glass into place.

MOUNTING WHOLE INSECTS

Small insects can be prepared for mounting simply by dropping them in turpentine. They are held in special, cell-type slides made from plywood and cardboard, as at right below, being cemented to the cell's bottom



This picture of a mosquito's wing shows the complex scale structure

in air, and then place it in turpentine under a cover glass. If the dry mount looks better, you can remove the turpentine merely by blotting, or by washing with xylol and drying. If, on the other hand, the specimen shows up better in the turpentine, it means that a balsam mount is preferable. Because balsam and turpentine mix perfectly, you can complete the mount merely by adding balsam.

When mounting scales or hairs in balsam, make sure that they are dry. Gentle heating over a flame or electric lamp will accomplish this. Put the specimen in a drop of xylol or turpentine, in the center of a slide, and then add a drop or two of balsam.

FOR dry mounts, you can use simple slides made by cutting a circular or square hole, slightly smaller than a cover glass, in a sheet of thin cardboard or plywood measuring one by three inches, and pasting the strip to a solid piece of cardboard. The circular cell should be in the exact center. If desirable, paint the bottom of the cell with black India ink. Then cement the specimen in position with balsam, and over it place a clean cover glass, its edges cemented in place with balsam.

There are several variations to this method. Some specimens, such as butterfly-wing scales, can be placed loosely in the cell without cementing. Very delicate specimens can be fastened by coating the bottom of the cell with a very thin film of balsam, and then making the film tacky with a drop of xylol just before introducing the specimen. In case you want to have the top of the cell so that it can be uncovered for close examination, you can omit the cover glass and fold a strip of cellulose wrapping material around the slide when it is stored away, to keep out dust.

If you desire to mount an entire insect skeleton or part of it (such as a honeybee leg), and find that the specimen is too opaque, try the following procedure: Soak for a week or so in a ten-percent solution of potassium hydroxide (ten grams of hydroxide to ninety cubic centimeters of water). A similar solution of ordinary lye can be used. This dissolves the softer tissues, leaving the chitinous skeleton and external details. If the horny chitin is not yet transparent enough, you can bleach it further, after washing thoroughly to remove the alkali, in hydrogen peroxide. Dehydrate by placing for a short time in dioxan, or by running it through a series of alcohol baths, and then mount in balsam. This method is used for specimens to be examined by transmitted light.

EXCELLENT specimens of hairs and other external appendages frequently can be prepared from the shed skins of insects and similar animals. Some larvæ shed their skins several times. The spider, which is not an insect but an arachnid, sheds its outgrown skin and leaves it in its web. Be sure that the shed skin is dry, then moisten it with xylol or turpentine and mount in balsam, taking care to exclude all air bubbles.

Two types of scales are seen in this view of a moth's wing. Some project from the edge like hairs, others overlap like shingles

Insect hairs and scales are not the easiest things to photograph through the microscope. They have a habit of being in such a position that they do not lie in the plane of focus of the objective. The only remedy is to search the slide until suitably positioned ones are found. If colored scales are being photographed, they generally show better if a color filter that renders them with considerable contrast is placed between the light source and the microscope. Most insect hairs are of a yellowish color. They are recorded with greatest detail in yellow or orange light, and with greatest contrast in blue light. Your plate or film must, of course, be sensitive to the colors of light used.

Trailing Rare Crystals WITH A MICROSCOPE

Myriad Forms of Startling Beauty, Originating in the Laboratory of Nature, Are Revealed with Your Lens

By BORDEN HALL

POPULAR SCIENCE MONTHLY
MARCH, 1933

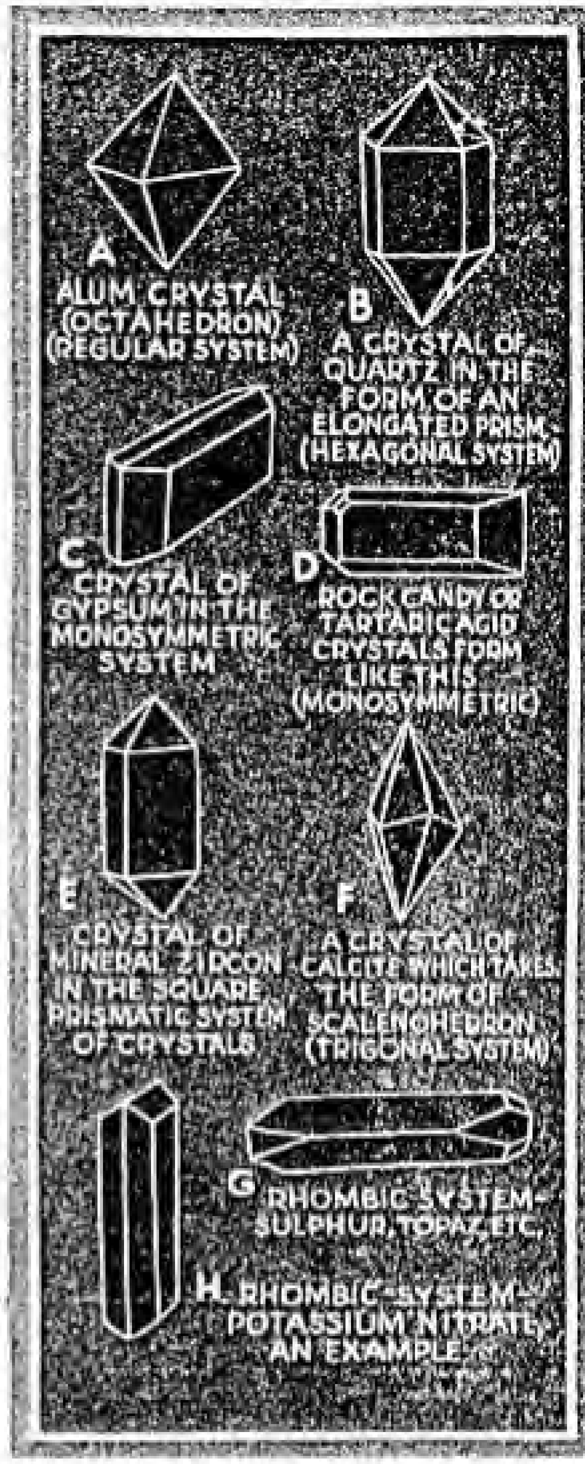
BEAUTY of form and color reigns supreme in the strange world of crystals. Into this exciting laboratory of nature, where mathematical exactitude is the law, we are now ready to enter. Here we shall find geometry blended with art—a combination making a powerful appeal to the scientific and the esthetic. And the key to this marvelous world of crystals is the lens of your microscope.

The instrument we use need not be elaborate. One that multiplies fifty times will meet our needs. In the examination of most crystal forms, high power is a disadvantage as many of the formations we desire to see are fairly large. It should be borne constantly in mind that the higher the power of the lens used the smaller the area covered. The really high powered microscopes thus afford us a peep at only a few thousandths of an inch at a time of the specimen under the lens.

In stirring a spoonful of sugar in coffee or sprinkling a bit of salt in consommé, we are unwittingly destroying millions of tiny, sparkling gems. Nature has divided most solid matter into two principal forms—the crystalline and the amorphous. Graphite and talc are members of the amorphous category. The crystalline, so beautifully represented by common table salt, is distinguished by the fact that its molecules, when they are normally associated, take certain definite positions that result in the formation of many types of crystals, some of them cubes, others oblong, hexagonal, or octagonal. Crystalline matter is really made up of countless millions of smaller crystals, all in perfect geometrical relationship to each other.

First, let us prepare a supersaturated solution of table salt. By supersaturated we mean that the hot water has dissolved salt until it cannot take in another bit. A microscope slide is wiped clean and a few drops of the supersaturated solution of table salt are placed upon it. This is then set aside for a few minutes to dry. When we return to it we shall find that the water has evaporated leaving a few tiny crystals.

The slide is placed on the stage of the microscope, under the two little clips, so that the salt crystals will be directly over the hole in the stage. The light is turned on and the mirror under the stage adjusted until a soft glow is produced. Now the objective is brought close to the surface of the crystals and the instrument focused upward until we see a number of little cubical gems, the box-like crystals of table salt. They have lost their perfect cubical form because a certain amount of distortion is caused by the solid articles with which they were in contact while forming.



In this diagram are shown a few of the many forms taken by crystals of different substances, each of which clings to its own type

All crystalline substances are classified, physically at least, according to the geometrical forms assumed. Alum takes the form of an octahedron. Those not acquainted with an octahedron are referred to Figure A in the drawing on this page. Figure B shows the shape taken by the crystal of quartz. These crystals are members of what has become known among the students of such things, as the Regular System and the Hexagonal System.

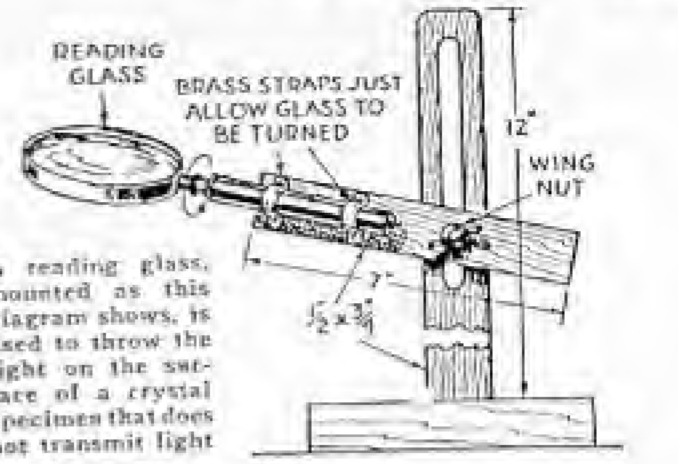
In our microscopic examination of crystal forms, we shall find that some crystals are much larger than others. We may be surprised to know that crystal may be grown from seeds to very large sizes, so large, indeed, that we need no microscope to examine them. Today radio stations

For most crystal formations, it is advisable to swing a lower powered objective into position as is being done in the photo above. This gives a wider view

The strange geometrical figures at right are the crystals of potassium sulphate as seen under a microscope. The crystals are more beautiful than the photo shows because they break up the light and are gay with color

The paving stone figure at left is really a crystal of common salt and it is not flat but is almost a perfect cube, slightly distorted by the surface it grew on

Here common household salt is being dissolved in hot water. Afterwards, a few drops will be placed on a slide and left to dry. Then the crystals can be studied



A reading glass, mounted as this diagram shows, is used to throw the light on the surface of a crystal specimen that does not transmit light

The amazing nest of tiny needles seen at the left was formed when baking soda was dissolved in warm water and then a few drops evaporated. The lens sees them as glittering, sharp pointed and colored jewels

When a bit of coal is magnified 200 times it looks like this and reveals its plant origin

are kept on their proper wave lengths by large crystals of Rochelle salts. These have the curious property of expanding and contracting at a definite frequency when excited electro-statically by radio currents. These crystals, so useful commercially, are developed from tiny seed crystals in the laboratory.

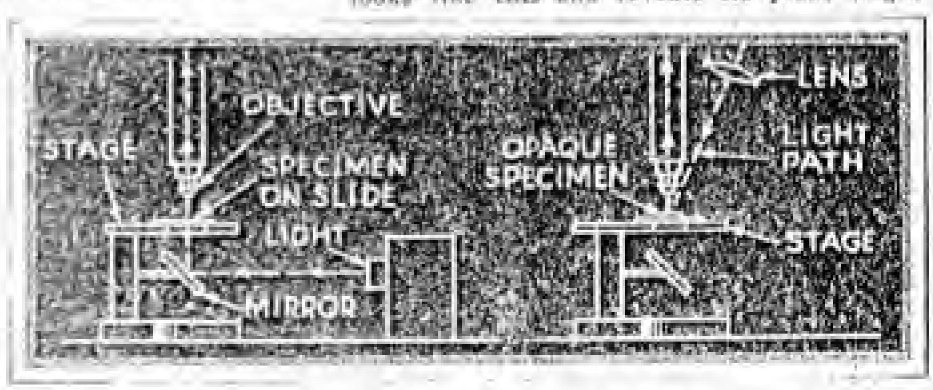
A supersaturated solution of ordinary baking soda is prepared exactly as was the salt solution. Again the slide is adjusted to the stage of the microscope and again we look at the result. Here we see crystals taking a needle-like form. We have left the Regular System. If we can obtain a bit of the mineral calcite (Figure F), we shall enter the Trigonal System. Quartz (Figure B) is a member of the Hexagonal System. Although quartz does not offer a very striking sight under the microscope, its industrial and domestic uses make it a most interesting substance.

Due to the manner in which nature has arranged the tiny bricks in quartz, it will pass ultra-violet light, which is kept out by ordinary glass. Cameras with quartz lenses will take pictures in perfectly dark rooms provided actinic, or ultra-violet, light is present. Windowpanes of these crystals are now used in hospitals and homes so that the full value of sunlight may be enjoyed.

Reference to the outline of crystal forms will acquaint us with the Rhombic System of which sulphur is a member. If a bit of melted sulphur is spread thinly upon a clean glass slide, it will crystallize upon cooling and we shall get a display of golden gems. This little smear of liquid sulphur on the plate, however, must be thin enough to transmit light.

It will probably astonish us to learn that great crystals of copper have been formed and are used to demonstrate properties in the metal that cannot be observed under other conditions. Such crystals have been built up to a weight of several pounds.

Potassium permanganate or potassium nitrate will supply other members of the rhombic system, the potassium permanganate being particularly beautiful under a powerful transmitted light.



Two diagrams above show how light is directed on to a crystal specimen. At right, light on opaque quartz and left, light on transparent object

But a far more exciting form of crystallization beckons us. It may be truthfully said that beauty, in its rarer forms, is unknown until we study the crystals of ice. Perhaps we have heard that snowflakes appear in an infinite variety of shapes and designs. Their architecture is one of the great wonders of the world, but we shall have to change our technique if we are going to examine them for here we are dealing with highly perishable objects.

So we must take the microscope and its light source to the garage, the woodshed, or better, right out of doors. If either the garage or the woodshed is chosen, it may be necessary to use artificial light. If so, remember that it cannot be too powerful nor too near the instrument. Otherwise the flakes will melt before we can get them under the lens for observation.

The slides to be used must be chilled to the approximate temperature of the flakes. This is done by placing them in snow and leaving them there for half an

hour. Then one of these slides is laid out where the falling flakes will settle on it. Flakes cannot be taken from the ground for there they are inextricably entangled with others and will be broken and destroyed before they can be brought to the stage of the instrument. Experience teaches that a dry, cold snow, without wind, provides the best flakes.

Snowflakes are examined under the microscope in the same manner as any other crystal that transmits light. No other crystal family, however, supplies such a limitless profusion of forms, there being, apparently, no end to their delicate, lacy patterns. Every snowflake is a distinct creation in a frozen world that contains countless trillions of other forms. Here geometry is wedded to sheer beauty. In looking at our flakes, we must not make the mistake of using a high powered objective. Anything from twenty-five to fifty diameters will be plenty.

STUDENTS of ice crystals have found two main classifications—the tubular and the columnar. Often the two forms are combined with the result that a column or rod of hexagonal section will have at one or both ends a hexagonal plate. Star-shaped crystals are most abundant when the temperature is just a bit below freezing. The hexagonal plates make their appearance in great profusion at lower temperatures.

Examination of the frost crystal that forms on windows reveals extremely interesting sights. A cold piece of glass moistened by blowing the breath against it, is placed in the garage where the moisture will freeze. Studying this specimen, we find the tiny little bricks of water have grown together, each, it would seem, clinging to the other for companionship in this barren and frozen world.

Aside from the crystals already mentioned, there are many others in the family medicine chest and the kitchen. Then at the drug store we may purchase copper sulphate, and the salts of the alkaline metals.

If we can obtain some crystals of galena or garnet, we can make some interesting observations. Galena, sulphide of lead, is the chief ore of lead.

We cannot examine this or any other opaque crystal as we did the transparent crystals. Galena is a dull gray and will not pass light. Hence the little mirror underneath the stage of our instrument will be useless, and we must manage to throw the light down upon the surface of the crystal. This is best done with a reading glass with a universal joint, set on a stand so that it may be focused at any point.

HAVING arranged the light source, we proceed with the examination. Here two hundred diameters or more, depending upon the skill of the operator, may be used. First, we must polish the surface of a tiny piece of galena. To do this, it is held against the side of a fine emery wheel and, when ground flat, is polished with rottenstone and water.

This done, the piece of galena, resting on a slide, is placed upon the stage of the microscope. Now the light is focused on the surface of the galena through the medium of the little reading glass and its universal joint.

Working at night with a microscope, we find that ordinary electric light is tiring to the eyes. To overcome this, we build a special light filter that is a real joy to use, and is easy and inexpensive to make. The inside of a coffee can is painted black after small holes for ventilation have been punched near the top and a large hole made for the escape of light. The beam of light from the can is passed through a solution of copper sulphate (or blue stone) arranged in a little container made of two small pieces of window glass. The wooden sides and bottom of this cell are made waterproof with tar or pitch.

Just enough of the copper sulphate is dissolved in water to impart a good blue color. This cell is then placed between the light from the can and the mirror on the microscope. In this position, it filters the heat out of the light and provides an illumination that does not cause eyestrain.

GET THE GOODS ON FABRICS WITH YOUR Microscope

By
MORTON C. WALLING

POPULAR SCIENCE MONTHLY

FEBRUARY, 1958

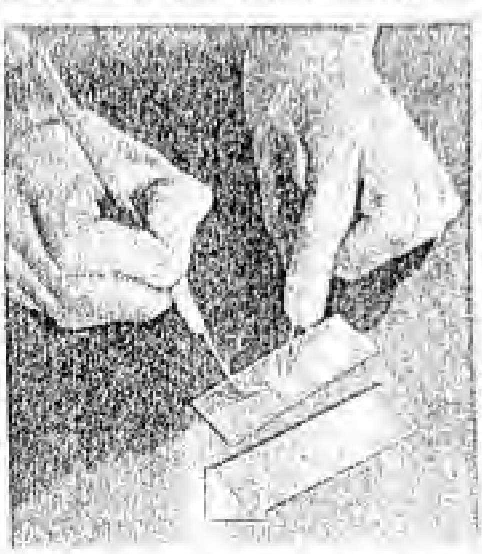
"ABSOLUTELY all wool," the salesman declares, displaying a suit. You finger the material and nod vaguely. The pattern and the cut appeal to you, so you buy the suit, greatly pleased with yourself for getting a bargain.

Perhaps the salesman is telling the truth. On the other hand, his natural anxiety to make a sale may have betrayed him into a slight exaggeration. You may notice, when you start wearing the suit, that it holds a crease for only a few hours after being pressed. The rest of the time, it looks as though you had been making it do double-duty as pajamas. Gradually the idea dawns on you that there is something wrong.

And that's where your microscope comes in. Snip a piece of excess cloth from one of the cuffs of the trousers, and lay it on a slide. With the instrument set for fifty diameters, you will see a network of threads spaced surprisingly far apart. However, a general inspection of the cloth in this way will tell you little. To get the real low-down on the fabric, you must tease a few threads out of the sample with a pair of dissecting needles and separate some of them into their individual fibers.

Lay a clean cover glass over the threads and examine them at a higher magnification than you used for the sample of cloth. Add water or xylol to increase their transparency. Probably you will see two different kinds of fibers, one cylindrical in shape with a scaly surface, the other resembling a flat, twisted ribbon. If you do, your worst suspicions regarding the suit are justified. The scaly, cylindrical fibers are wool, the twisted, ribbon-like ones cotton.

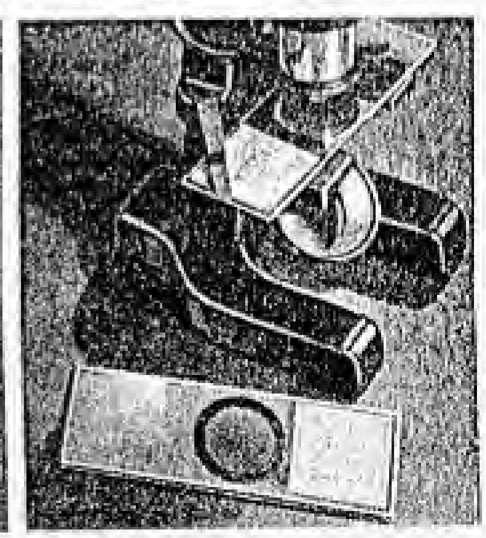
Identifying textile fibers is one



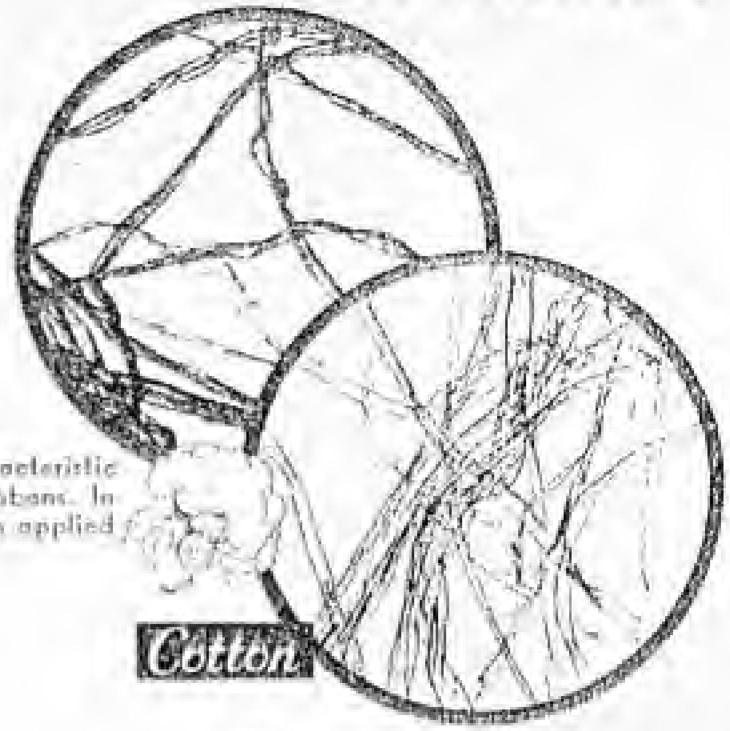
To prepare a piece of cloth for examination, first tease out individual threads and fibers

Adding xylol, water, or other liquids often makes fibers more transparent, improving detail

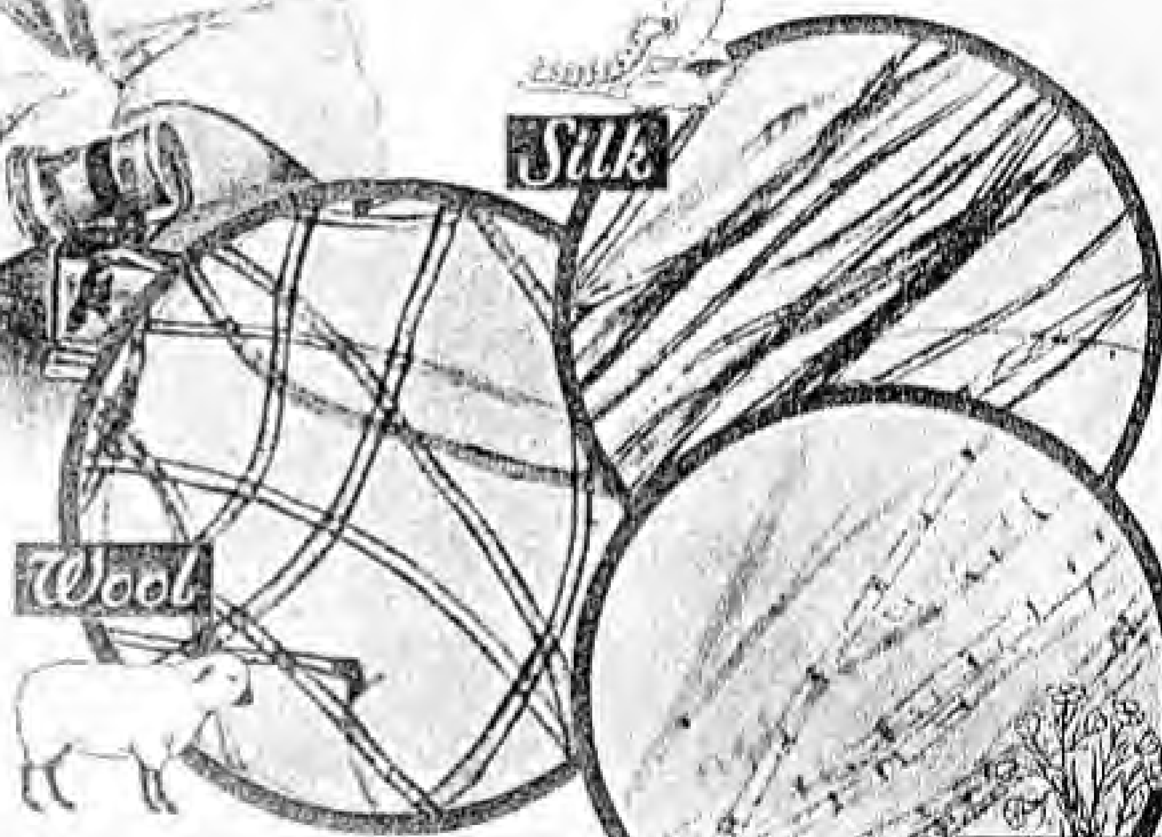
For staining, textile dyes or standard microscope stains will be found to serve the purpose



Finished slides should be labeled neatly and filed away for future reference and comparison



Cotton fibers, showing the characteristic resemblance to flat, twisted ribbons. In the lower picture, xylol has been applied



Samples of cloth being checked for uniformity of thread size and spacing. Photomicrographs at right, above, show fibers of silk, wool, and linen as they appear when magnified. Note their distinguishing qualities

of the most fascinating things you can do with a microscope. It becomes a simple matter, after a little experience, to distinguish cotton from wool, wool from linen, linen from silk, and silk from the various rayons. It is but a step farther to become familiar with a wide variety of other textile fabrics.

Examination of fabric construction is another important operation. With the familiar "linen tester," a simple microscope whose stand is equipped with a scale, the number of threads to the inch in a sample of goods can be determined accurately, and major imperfections discovered. At the higher magnifications, given by a compound microscope, much more can be learned about uniformity of weave, variations in thread size, and damaged fibers and threads.

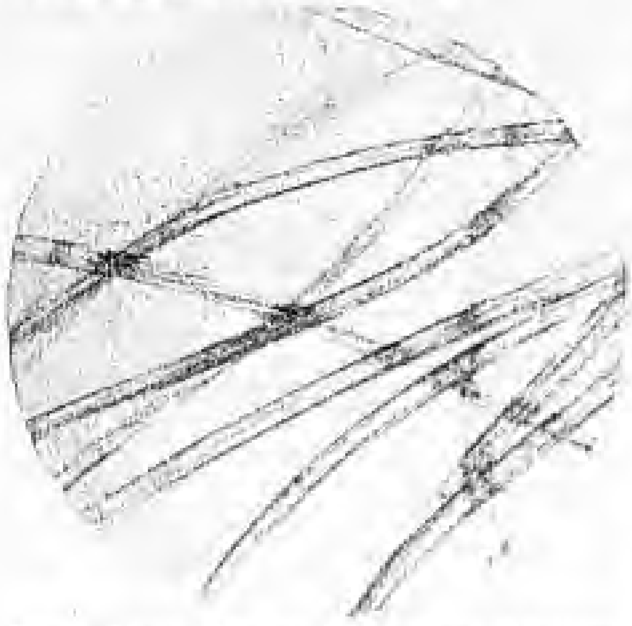
At magnifications high enough to reveal details of the individual fibers, various things affecting the quality of a material can be seen. Thus, the fibers may show numerous breaks and fractures, as a result of careless processing. When the material is composed of two or more kinds of fibers, the relative amounts can be estimated closely with the microscope, or separated and weighed for more exact determination.

Dye action can be examined with the microscope. Thus it may be discovered that a certain woolen material takes dye poorly because the interior tissues, called medullary canals, in the individual fibers, are closed.

The technique of making microscopic examinations of textiles is not at all difficult. In fact, cloth is one of the best materials for the beginner to use in becoming familiar with the handling of his microscope. It requires but a few seconds to cut a piece of fabric to the size of your little finger nail, lay it on a clean slide, and start examining it at any convenient magnification.

It is wise to examine each textile specimen in both dry and wet mounts. A dry mount is made simply by placing a specimen of cloth on a clean slide. It may be desirable to lay a cover glass or another slide over it, to hold it flat and in position. Always tease out several threads at one edge, and tear them apart to reveal the individual fibers, when you in end to examine the detailed structure of the specimen.

After you have studied the specimen in its dry state, try wetting it with water. Simply place a drop or two of water at the edge of the cover glass, and let it soak into the piece. Use enough water to eliminate air bubbles, but not enough to make the cover glass float. You will note that the cloth appears more



Rayon fibers, showing longitudinal striations

transparent, and details of fiber structure are easier to see.

Next, try xylol instead of water. Xylol is a common clearing agent. It also is a solvent for Canada balsam, which you use in making permanent slides of cloth samples.

To make such a permanent slide, simply place the sample on the slide, loosen a few threads and fibers, and drop a little xylol on it. Hold the cover glass horizontal, and put just enough balsam on it to immerse the specimen completely. Lower the cover glass, balsam side down, on the specimen, and press it gently to spread the balsam. This treatment increases transparency of the fibers greatly—sometimes too much.

AN IMPROVED method of mounting that reveals *surface* details as well as internal ones better, was worked out recently in Germany. It employs a material called niglytin, a mounting medium containing a black pigment. Best results are obtained with only a few fibers of fairly uniform diameter, arranged so that they do not cross. The cover glass is pressed down until the fibers touch both it and the slide. The niglytin holds back much of the light that otherwise would pass around the fibers, but lets light pass through them. The effect is much like that obtained with dark-field illumination.

If you want to stain textile fibers, try some of the textile dyes obtainable at drug stores. Standard microscopic stains that will work with animal and vegetable materials can be used equally well. Usually, staining is not necessary.

Examination of such cross sections is important, in the accurate grading of wool. Wool from one sheep may contain fibers of uniform size, while that from another contains various sizes. Some strands may be oval, while others round. All these things affect wool quality.

Wool and hair fibers are essentially the same. The term wool usually is applied to the fleece of sheep, while hair fibers include the hair from alpacas, camels, goats, and other animals. Most animals producing woolly fleece also produce some hair fibers. Thus the wool from sheep contains beard hairs, which are of different appearance under the microscope.

Careful study of a typical wool fiber through the microscope will reveal many of the reasons why woolen goods are so desirable for clothing. You will see, as you look at a bit of wool at about 250 diameters, a cylindrical rod covered with fine, wavy lines. These are the boundaries of scales that form the epidermal covering. The scales, or flattened cells, overlap like the scales

Know Your Instrument

TO GET the most out of books and articles on microscopes, you should be familiar with the language of the subject. Thus, when somebody speaks of the "ocular," you will know that he means the lens or system of lenses at the top of the microscope tube, to which you place your eye when you look through the instrument. The ocular also is known as the eyepiece. Other important parts of a compound microscope are:

Objective—the lens or system of lenses at the lower end of the body tube, directly above the object.

Body tube—the metal tube that acts as a support for objective and eyepiece lenses, and forms a light-tight housing for them.

Revolving nosepiece—a disk-shape attachment at the lower end of the body tube, into which the objectives screw. Pivoted, it revolves to bring objectives into position.

Base—the casting, usually shaped somewhat like a two-toed bird's foot, that rests on the desk or table top and acts as a support for the rest of the instrument.

Arm—this is the rigid member that is pivoted to the base, and to which are fastened the various other parts.

Inclination joint (pivot)—the joint between arm and base, which permits the microscope to be broken over at an angle for more comfortable observing.

Pillar—this is a projection from the base, to which the arm is pivoted. The pillar and the part of the arm nearest it resemble a hinge assembly.

Stage—the platform, with a hole in the center, on which glass slides are laid.

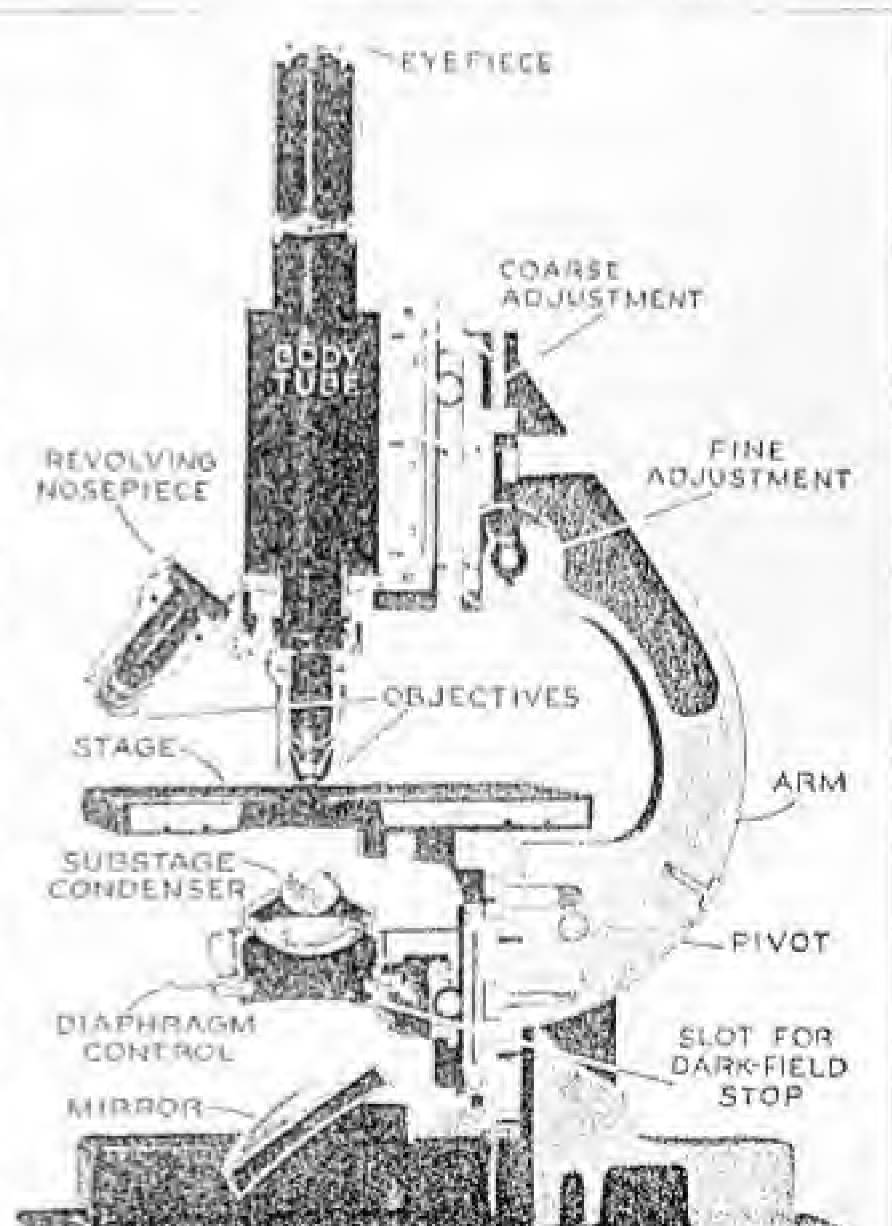
Substage—the assembly of accessories beneath the stage, including the substage condenser (Abbe condenser), iris diaphragm for controlling the diameter of the light beam reaching the object, and a mirror for reflecting light up to the object.

Substage condenser—a system of lenses designed so that they concentrate a beam of light on the object.

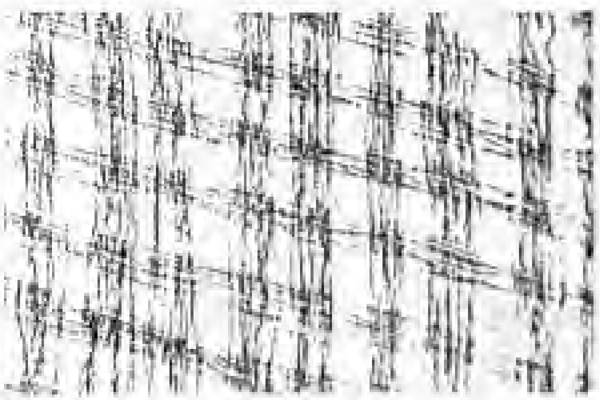
Spring clips—two flat pieces of springy metal, pivoted at one end, for holding the slide in position on the stage.

Coarse-adjustment knob—a knurled knob by which rough focusing is done; it produces considerable body-tube movement at each revolution.

Fine-adjustment knob—a vernier knob that produces only slight movement of the body tube at each revolution.



on a fish. Their saw-tooth edges, all pointing in the same direction, give the fiber a one-direction roughness that is a very valuable property. A wool fiber is much like a rat-tail file in construction. Contrasting with wool fibers and their prominent scales are the hair fibers whose scales are difficult to see because they project so little.



Magnified piece of a handkerchief made of natural silk. Note the looseness of the weave

It is upon the scaly nature of wool that the highly important "felting" property depends. Felting simply means that the fibers interlock to make a dense mass. The action is hastened by warm water, soap, and friction. The water and soap soften the epidermal cells so that the fibers get a better grip on each other. That is why a woolen article may seem so much denser and stronger after being washed two or three times: the yarn has tightened up as a result of the felting action. Felt, as used in hats, is made by mixing rabbit fur or other hair under conditions that make it unite into a mass.

INSIDE the epidermal layer of a wool fiber is the cortical region. This is a system of long cells that contribute to the fiber's strength and elasticity. By careful focusing on a plane passing through the fiber, you may be able to see the lines marking the cell boundaries. Finally, in the center of the wool fiber is the medullary canal, in which pigment and granules frequently can be seen. Some wool fibers do not show these canals. The medulla, a tiny tube-like formation, takes up dyes and other liquids by capillary action. When wool does not dye well, the canals may be closed as a result of contact with lime, or some other cause.

Cotton is the hair from around the seed of a cotton plant. While such a hair is growing, sap is circulating through it. When it is ripe, the sap flow ceases, and the hair walls collapse, perhaps from vacuum action. This converts the hair into a flat ribbon, which shrinks and twists as it dries. Thus, under the microscope, a cotton fiber resembles a ribbonlike shaving that is very much twisted. The medullary canal is usually visible.

LITTLE or no twist may mean several things. The fibers may have been dead or unripe when picked, or they may be mercerized. In the process of mercerizing cotton, the cuticle or outer layer is dissolved away with strong alkali. The cell walls swell and expand. Because the cloth is under tension during the process, much of the natural twist of the fibers disappears. Mercerized-cotton fibers appear, through the microscope, as smooth cylinders with considerable luster.

Linen is the strong bast, or woody, fiber obtained from a flax stalk after the bark has been removed. Under the microscope, the cylindrical fibers look very much like tiny stems of glassy bamboo. They are marked at intervals by fine cross lines and sometimes by small notches.

Silk can be distinguished from all other textile fibers of natural origin by the absence of cellular structure. A strand of natural silk consists of two threads cemented together. The silkworm produces the strands by ejecting a transparent fluid from two gland openings beneath its lip. As the two strands are formed, they are cemented together to form one. Silk fresh from the cocoon is covered with silk gum, which is removed by boiling. This leaves the characteristic silk strand visible under the microscope, an almost endless cylinder, transparent and lustrous.

RAYON, an artificial silk, is made by squirting cellulose preparations through small orifices and hardening the resulting strands by chemical action as they are formed. These strands look like tiny glass rods or ribbons, and frequently have lengthwise striations, or parallel grooves. They are distinguished from genuine silk by the absence of a dividing line and silk's high luster, and by the presence of occasional specks, granules, and air bubbles.

As an amateur microscopist, you have a special reason for learning to know cotton and wool fibers when you see them. Stray ones from your clothing have a habit of turning up under cover glasses, no matter what you are trying to examine. If you know these fibers, you won't mistake them for something else.

Seeing Through Coal with Your Microscope

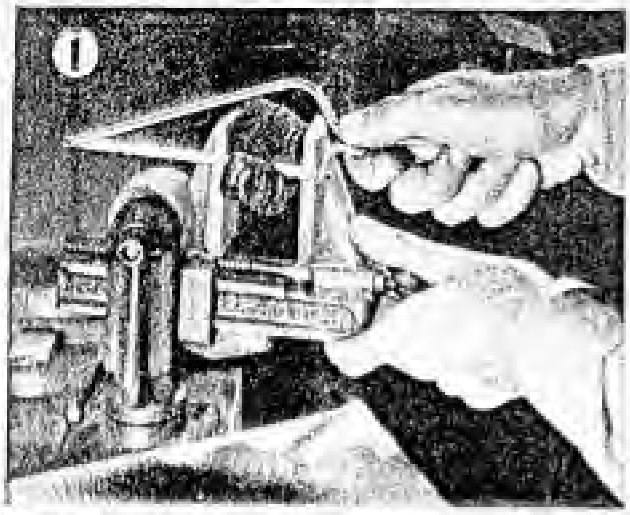
POPULAR SCIENCE MONTHLY
MARCH, 1938

By MORTON C. WALLING

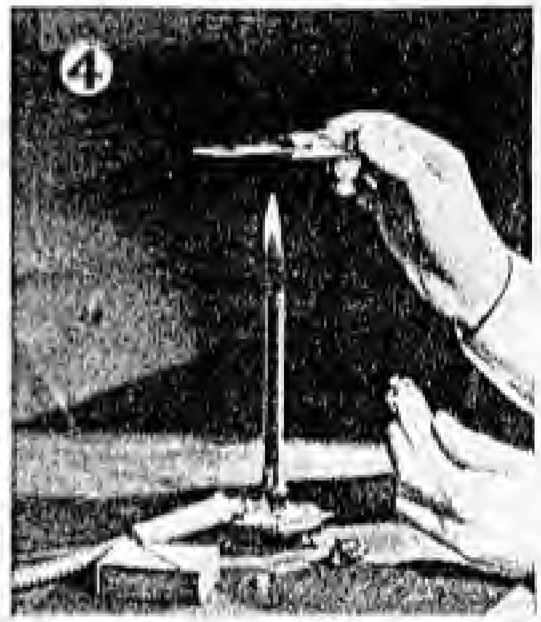
This Article Tells You How To Prepare Specimens of Rock, Bones, and Minerals, Using the Very Same Methods That Are Employed by Research Workers in Large Laboratories

A flattened spore of a prehistoric plant, seen in coal. Right, cross section of a bone

TO THE average person, the idea of passing light through a piece of coal sounds like magic or pure hokum. Tell him that coal isn't always black, but sometimes red or yellow, and he will stare at you incredulously. But the microscopist, whether amateur or professional, knows that there is hardly such a thing as an absolutely opaque substance, and that many common objects reveal unsuspected qualities when viewed under the magic lenses. With your own instrument you can



With your microscope you can unearth secrets of nature in fossils, bones, and minerals



HOW A SLICE OF COAL IS MOUNTED FOR MICROSCOPIC EXAMINATION

1. With a small hack saw, cut a piece from a chunk of coal to make a flat surface
2. Grind the cut surface smooth on an abrasive stone that is immersed in water
3. Or, if you prefer, you can saw off the slice before polishing either surface
4. Warm some balsam on a slide to harden it for cementing the coal to the glass
5. Grind down the mounted slice and finish on a cloth pad charged with metal polish

look through coal, and also through bones, rocks, and sea shells.

The secret of seeing through normally opaque, hard materials lies in the process of preparing them for the microscope. This consists essentially of slicing them into sections thinner than the finest tissue paper. It happens that practically the same steps are followed in preparing a considerable number of different kinds of hard materials to make them translucent enough to examine. Such materials include coal, bone, sea shells, teeth, fossils, peach stones and similar dense seeds, foraminifers, and coral. In fact, it is a relatively easy matter to prepare thin sections of any hard substance, except those that are made up largely of silica, with the aid of a few inexpensive tools.

Although the process of making thin sections of hard materials will be described with no specific substance in mind, you will find ordinary coal convenient to use until you have acquired some skill. Coal is easy to obtain, simple to work, and contains a surprising number of microscopic details unsuspected by some persons. Another easy substance to work is bone, such as that from beef.

In making thin sections, the first step is to obtain a flat surface. With coal, bone, and the like, this is done by slicing the specimen in the direction in which the section is to be made. That is, if you want a cross section of a bone, cut it crosswise. A thin-bladed metal saw, such as a small hack saw, can be used for bone, coal, fruit seeds, and so on. For harder objects such as teeth, a metal disk charged with diamond dust or some other abrasive is better, but usually is not available to the average amateur microscopist. Perhaps you can

find a local gem worker, jeweler, or optician, who will do the cutting for you.

After the cut has been made, it is necessary to make the surface of the part to be used as flat as possible. You can do this by rubbing it back and forth on a rough abrasive stone lubricated with water. A stone of a texture about like that of an old-fashioned grindstone will do. In Government and other laboratories where many such sections are worked, horizontal, power-driven grinding wheels, operating in a stream of water, are employed.

After the first grinding to level off the surface, change to a finer-grained stone, and rub until the grooves made by the first stone are removed. You generally can obtain suitable stones from the ten-cent store. Use water as a lubricant.

Continue the polishing operation on a razor hone lubricated with water. At little cost you can obtain fine-textured razor hones that will put a high polish on most specimens. Sometimes two-surface stones are available, one surface being moderately fine-grained and the other extremely so.

It may be that no polishing other than that on the fine-grained razor hone will be necessary. But if there still are fine scratches in the surface, further polishing on a cloth pad charged with some abrasive material will be desirable. Some laboratories have found that certain prepared silver polishes work satisfactorily as final polishing agents for coal and the like.

When the first surface is finished, it is necessary to arrange the specimen so that it can be held while the second surface is polished, and the thickness reduced to the desired degree. It is possible, with most specimens, to use the saw again, and cut off a thin slice from the polished end of the piece. Sometimes this slice can be worked down by holding with the fingers while it is pressed against the stones. When the specimen becomes very thin, use a piece of cork or rubber to hold it while you are rubbing it back and forth.

However, since this method can be used only with such tough articles as bones, and then not always with success, it is best to cement the specimen to a glass support. A piece of thin plate glass, or a standard one by three-inch microscope slide, will do. The cement can be Canada balsam, marine cement, or a mixture of the two. For most purposes, the balsam will work excellently. Place a drop or two of it in the center of the glass and warm it gently over a flame. This drives out some of the solvent and causes the balsam to thicken. Do not heat enough to cause bubbling. After a time, let the slide cool, and test the balsam with your finger nail. If you can dent it easily, heat some more; if the balsam is brittle and easily cracked when cold, you have heated too much, and must add some unheated balsam and warm again.

After the balsam is found to be just right, warm it until it becomes tacky, and press the polished side of the specimen against it. It is best to bring one edge of the specimen in contact with the balsam surface first, and then gradually lower it so that air imprisoned underneath it is carried across and out the other side. Let the slide cool.

Rough grinding is done on the second surface exactly as on the first. Be careful not to carry the operation too far, or you will reduce the thickness to a point where the specimen will be difficult to polish.

Now polish the specimen on successive stones and a cloth lap as before. When you have worked it down to a thickness of a few microns (thousandths of a millimeter), you will find that some places are thicker than others. With a little patience, you can use silver polish or some other abrasive and a cloth to work these spots down. In this, as in all other polishing operations, make frequent examinations with your microscope. Many specimens can be ruined by making them too thin. When the details appear to be satisfactorily rendered, and the surface smooth enough, discontinue the polishing operation.

BEFORE mounting your specimen, you probably will find it desirable to remove it from the glass support and clean it. Immerse the support in xylol or dioxan, to dissolve the balsam. With fine-pointed tweezers, very carefully remove the specimen and transfer it to its new support, washing further in the solvent to remove bits of dirt if necessary.

It may be possible, as usually is done with coal, to leave the specimen cemented to the support, and simply add a little balsam and a cover glass. In such cases, the support of course should be a standard microscope slide. Even though it might be desirable to loosen the section and wash it to remove particles of dirt, some specimens are so fragile that it is unwise to attempt this.

Mounting is one of the most important steps in the process, for the final appearance of most specimens depends on the way they are mounted. Sometimes the use of balsam as a medium will destroy detail, while at other times it will amplify it. As an example, cross sections of bone show tiny openings that resemble pores. In air, these appear as dark spots, while in balsam they may be scarcely visible. Therefore, bone sections usually are best when mounted dry, or when mounted in balsam in the following manner:

COVER both the cover glass and the slide with balsam, and heat it until it hardens upon cooling, just as you did

Make Your Own Tweezers

IF YOU have trouble finding suitable tweezers for microscope work, you can easily make your own. Obtain some strips of bronze, spring brass, or stainless steel, and cut two pieces of the shape desired. Aften bending them so that they curve slightly, place them together with the concave sides next to each other, and rivet or solder the handle ends. You will find it worth while to make several shapes. A good selection includes a pair of the needle-pointed kind, preferably made of stainless steel; heavy, round-nosed ones for rough work; and a pair of "duckbills" with thin, flattened tips.

when cementing the specimen to the glass support before grinding and polishing the second surface. Lay the section of bone on the balsamed surface of the cool slide, and lower the cover glass, balsam side down, over it. Now gently heat the assembly, and when the balsam is liquid (it should not be flowing) press the "sandwich" together, so that good contact is obtained. Let it cool. If the job has been done properly, the balsam holds the specimen securely, but has not flowed into the tiny openings to obscure them. You can add balsam around the edges of the cover glass, to fill any surrounding spaces.

In this way, you can unearth secrets of nature that otherwise would remain hidden from your sight forever. You will be following steps identical with those taken in research laboratories devoted to the study of coal, fossils, and bony materials.

COAL, for instance, probably will surprise you, for you have been thinking of it all along as a black, uninteresting mass. Your first surprise may be to learn that coal in thin section is not necessarily black, but may be red or yellow. Scattered throughout the coal you may find such objects as the yellow, flattened spores of ancient plants, pollen grains, red clumps of fossilized resin, leaf fragments, woody particles which usually are red in color, and various other plant fragments—for coal is a material made from the remains of ancient vegetation. Your chances of finding ancient seeds in coal are slim, for most coal-forming plants were much too primitive to form seeds.

The spores in coal have been distorted from their original shape by great pressure. They originally were round, but pressure that reduced the deposits of plant remains to thin layers has flattened the spores into tiny, double-walled pancakes. Such spores may appear as tiny yellow disks or as flattened loops, depending on the direction in which they were sliced.

Although you can slice bones in any direction, cross sections generally reveal more interesting details. You will find that typical bone structure looks as if it had been built up of parallel rods cemented together. In the center of each rod is an opening, the Haversian canal, through which blood vessels and nerves pass when the bone is living.

AROUND these canals are concentric striations, something like the rings of a tree trunk. Scattered through the area are tiny spots which may appear black, but which really are minute openings. These are the lacunas—cavities occupied, in the living bone, by bone cells or "bone corpuscles." These are the openings that balsam renders difficult to see when it is used as a mounting medium, although they and the canals may be filled with debris from grinding, and appear black. Threadlike processes interconnect them, so that the cells form a network that receives nourishment from the blood vessels in the Haversian canals.

The microscopic study of bone is an important job of science, for it leads to discoveries of importance in the treatment of diseases and in better understanding the animal body. Microscopists skilled in the study of bony materials can identify small fragments, for bone structure varies in different animals. The microscope can be used to catalogue bones from prehistoric deposits.

Microscopic Marvels YOU CAN FIND IN *Your Workshop*

POPULAR SCIENCE MONTHLY

DECEMBER, 1933

How Experts Mount Specimens and Identify Metals by Their Crystals and Woods by Their Cell Structure

By MORTON C. WALLING

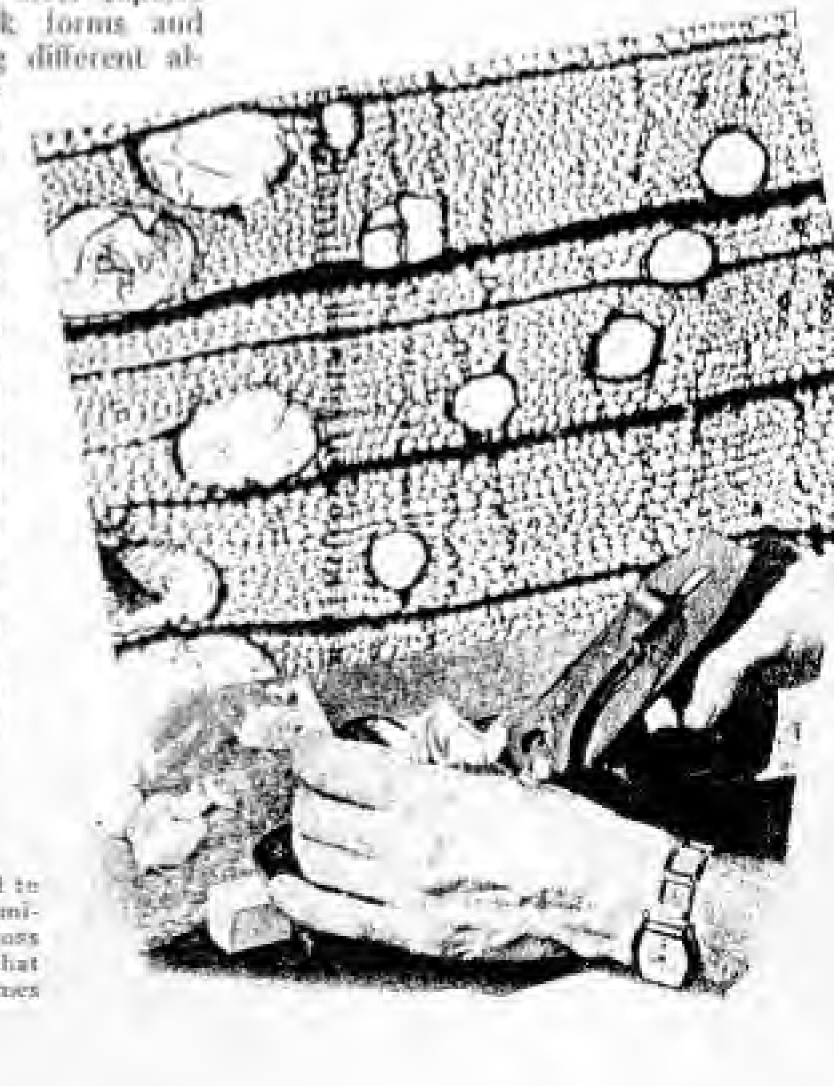
PERHAPS the chief reason why the use of the microscope is growing in popularity as an instructive and fascinating hobby is that it makes two worlds visible where only one was seen before. This is true of any shop, whether it be your own place in a corner of the basement or a unit in a giant factory.

Visit your workshop or that of a friend. Look about you. There are lathes, power saws, drill presses, hand tools of all kinds, scraps of iron and steel, a pile of lumber, and a box full of odds and ends. Your interest in these things is determined by your knowledge of their purposes and the manner in which they are used.

Now take your microscope into the same shop and peer through it at the various things you find there. You will discover beauty in the scrap box, romance in a rusty piece of steel, a fascinating story in the dust that collects around a grinding wheel, mountain ranges on a file, and a host of other things that you never even dreamed were there. The microscope, in fact, proves that every shop is really two: the normally visible one of tools, steel, and wood; and the one of cells, crystals and particles that is revealed by your microscope.

When you grind a piece of metal on an abrasive wheel, showers of beautiful sparks fly off. For years, steel experts have been observing spark forms and colors and thus identifying different alloys. But the method has its limitations, for some metals defy identification in this way.

With your microscope, you are prepared to follow the steps of metallurgists who, not long ago, found a way of going the spark system one better. Place in front of the grinding wheel, a sheet of newspaper folded so that it will catch the dust driven off when you grind a piece of steel. Select a piece of metal that will produce sparks generously, such as an old file. Hold it against the wheel so that the spark shower will

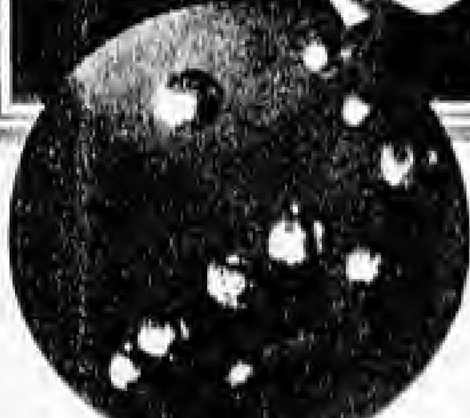


HOW YOU CAN STUDY WOOD

Right, a plane may be used to get wood sections for the microscope. Above it is a cross section of black walnut that is enlarged about 60 times

SPARK DUST

At left, a file is being held against an emery wheel. The sparks that fly off are caught in a paper so they can be placed beneath a microscope's lens. In the circle, how the spark dust appears when enlarged about 50 times. Below, emery wheel dust and steel pellets, the twisted fragments being the steel



be directed into the paper, and continue grinding until you have a little pile of dust.

Place a small amount of the dust on a glass slide and put it carefully on your microscope stage. Adjust your lenses for a low power, say thirty to fifty times, bring your homemade illuminator into action, and look into the eyepiece.

You will see little angular pieces that look like irregular jewels when illuminated from almost any angle. They are particles from the wheel, and are either dark or light in color, depending on the kind of abrasive used. Mixed with them are ragged, twisted pieces of metal, chips torn off by the thousands of sharp teeth on the wheel face. Here and there, you also will see little globules or spheres. Perhaps their surfaces are smooth and shiny; perhaps they are pitted. They are tiny bits of metal that, when molten, you saw as sparks flying off from the wheel. It is these pellets that are proving of importance in the steel industry.

Metallurgists at a large manufacturing company discovered that there is a definite relation between the form of the grinding wheel pellets and the composition of the steel that produced them. It happens that steels, difficult to classify by the spark test, can, in many cases, be identified by examination of their pellets. You can have a bit of fun collecting pellets from different kinds of metal objects and looking at them through your microscope.

Even if your instrument is not a very powerful one, it will show you the structure of metals just as the expert microscopist in a steel plant laboratory sees them. The microscope is largely responsible for development of metals and alloys that make possible the automobile, airplane, and almost every other piece of modern machinery. Under its revealing eye, the crystalline grains of metal are as plain as the bricks in a pavement.

Iron and steel being the most common workshop metals, you doubtless will want to examine them first. If specimens of them are prepared in the manner about to be described, their structures can be seen with a relatively low-powered microscope.

Nearly pure iron exhibits beautifully the crystalline grains that make up metals. These grains, when the metal has been polished and etched lightly with a chemical, are outlined by fine lines. Further etching results in a change in color and tone of various crystals. Still deeper etching often brings out the three-dimensional form of the crystals.

Metallurgists have given names to the various things that can be seen in a piece of iron or steel. If you examine wrought iron, you will see dark streaks or spots extending through the crystals. These are slag particles, elongated by pressure used in shaping the metal piece. Some carbon may be present, but it, in union with other materials, is found between the crystals rather than inside them.

Mild or low-carbon steel is nothing more than wrought iron from which the slag has been removed. In structure, low-carbon steel is a mass of carbonless iron crystals, which the metallurgist calls ferrite, with here and there between grains, dark patches containing the carbon. These patches sometimes shimmer in the light like mother-of-pearl, which is the reason the substance forming them is called pearlite.

When sufficiently magnified, these pearlite spots are seen to contain alternate dark and light streaks or plates. These may be about 1/25,000 of an inch thick. The dark streaks are ferrite or iron which has been stained by the etching solution. The light streaks are iron carbide or cementite. It is interesting to note that genuine mother-of-pearl is made up of layers of thin plates that reflect light in a striking manner.

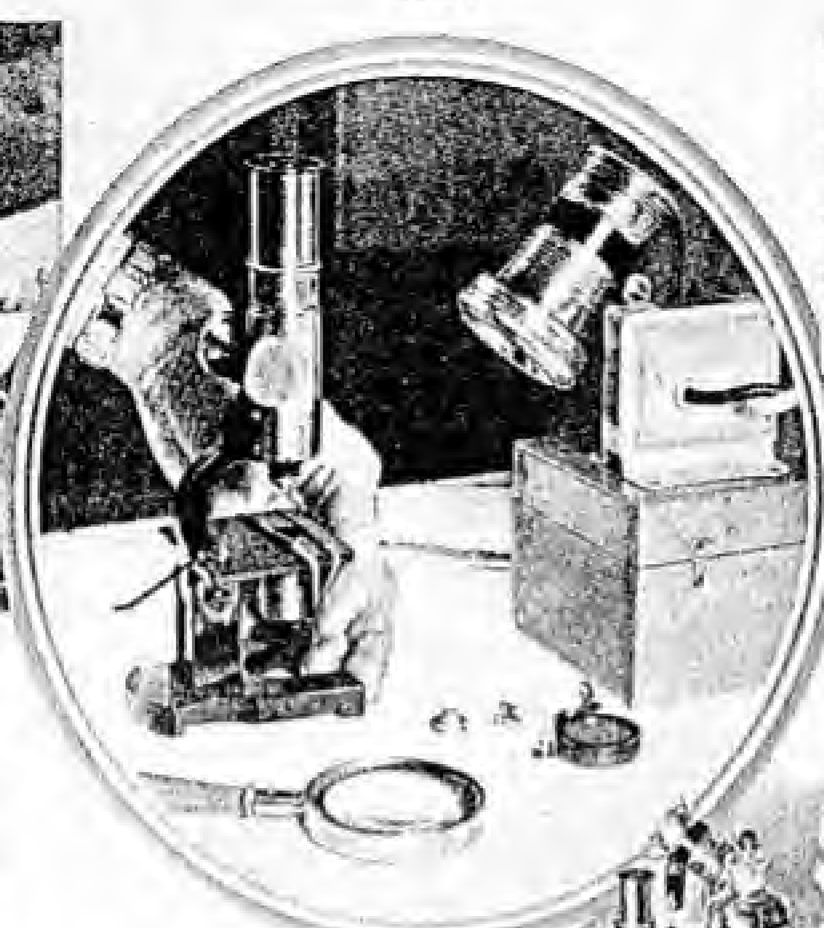
As the amount of carbon in steel is increased, the areas of pearlite become larger and the grains of ferrite smaller until, when the amount of carbon is nine-tenth percent, the steel is all pearlite.

The preparation of specimens of iron and steel for study is not complicated. You will be wise to start with cast iron, because it responds readily to the treatment. Later, you can tackle more difficult material.

Although many steels have to be heated to about 1,800 degrees Fahrenheit and then cooled slowly in order to remove strains and make the structure uniform, you will not have to do anything of the sort to cast iron.

File or grind the surface to be etched, until it is bright and smooth. Then polish it with abrasives of increasing fineness until the metal has a mirror-like appearance. You can use emery paper for rough polishing, starting with a fine grade, and finishing with the finest you can get. Another way is to make a lap by tacking a layer or two of broadcloth over a wood block, wetting the cloth, and sprinkling fine powdered emery over it. For final polishing, use powdered rouge and a lap similar to that employed for emery.

The next step, after carefully washing



LOOKING AT STEEL

Above, polishing a steel pipe cap with emery and powdered rouge is the first step in preparing it for the microscope. At extreme right, etching steel with nitric acid to bring out the crystals. In circle, specimen held to stage of instrument with rubber band. Note: light that is used is nearly vertical

and drying the polished surface, is to apply the etching solution. Its action on the metal surface causes the grain structure to become visible. Some parts are attacked more extensively than others. Also some of the materials in the metal are colored differently from others. There are several different kinds of etching solutions that you can prepare.

One reagent consists of five grains of picric acid in about three and one half ounces of absolute alcohol. Immerse the metal for thirty seconds.

Another etching solution is prepared by mixing one part of nitric acid (concentrated) with nine parts of alcohol. Etching is complete in ten to fifteen seconds.

Ordinary tincture of iodine can be used. Spread a drop of it on the polished surface and let it remain until the metal is discolored.

PERHAPS the quickest and simplest way is to dip the polished surface of the metal specimen into concentrated nitric acid and immediately plunge it into water. The acid can be dropped on the metal with a medicine dropper, instead of dipping. In this process, etching does not start until the acid has been diluted with water, and it continues only for an instant because of the rapid dilution.

Your specimen of cast iron can be examined under a low magnification. If the polishing and etching have been done properly, the structure of the metal will be seen plainly, its exact nature depending on whether the cast iron is white, gray, or mottled. Some specimens will show light, irregular patches of ferrite surrounded by free carbon or graphite. Cast iron contains carbon, silicon, phosphorous, sulphur, and manganese in addition to iron. It differs from steel in having more carbon, part or all of which may be in an uncombined state. The carbon percentage may be between two and five-tenths and four per cent.

Well-equipped metallurgists use vertical illumination for examining and photographing metal specimens, the light being directed downward through the microscope objective and then reflected back up through the same lenses. However, you can obtain satisfactory results by directing one or more beams of light downward on the metal, making them as nearly vertical as possible.

Move your microscope from the scrap-metal pile to the lumber rack, and you will find material for hours of fascinating entertainment. By looking at bits of wood, you will learn why some kinds are stronger than others, why some are flexible, and how the arrangement of cells determines grain pattern.

In wood, the cell is the building block. Cell structure determines whether the wood is stiff or flexible, heavy or light, soft or hard. Cell arrangement also determines the appearance which, in many cases, is the property of greatest value. Woods can be identified definitely by microscopic examination of cells and their arrangement.

IF YOU examine the end of a piece of oak under the lowest power of your microscope, you will find it is made up of circular cells, somewhat resembling a honeycomb from which the surface has been scraped. The cells are arranged in curved layers. If you could see the whole tree, you would find that these layers form rings, each representing a year's growth. Towards one edge of each layer are a number of very large cells. This part of the wood grew in the spring. The remainder, in which these cells are smaller, is summer and fall wood.

A piece of lumber made up mostly of spring-grown wood is not as strong as that which grew in the summer and fall. Here and there through the specimen, you will note streaks of cells that run roughly at right angles to the seasonal rings. These are the medullary rays which in the living tree serve to carry water between the inner and outer parts of the trunk and to store excess food.

Trees with broad leaves, such as the oak and maple, have three kinds of cells. The majority are wood fibers, which are long, narrow cells varying in size. If you look at a thin slice of wood cut parallel to the grain, you will see that the fibers are tapered at the ends and fit together like dovetail joints.

A second type of cell is the tracheid. It is wider and shorter than the fiber and its ends are not as sharp. The opening through it is wider and there are thin places in its walls, called pits. These pits, in life, are useful in water circulation. Sometimes the wood can be identified by the shape and arrangement of these pits.

The third type of cell is the vessel or duct, which resembles a sectional sewer pipe, and is made from rows of tracheid cells. These vessels may be a yard long and one one-hundredth inch wide in some trees. Walls are pitted.

While studying the wood fibers, you might compare them with steel. They are remarkably strong, sometimes possessing, according to some botanists, one fourth the tensile strength of steel, and one half that of wrought iron. You can find much entertainment in examining the structure of wood that has broken under a load or stress, and noting the odd shapes the fibers assume.

Coniferous woods, such as pine, do not have vessels or fibers. They are made up almost entirely of tracheids with pits that can be seen in the walls. The tracheids in pine are about one-sixteenth inch long. They serve both to produce strength and carry water. In examining a cross section of pine, you will notice that there is an abrupt change from spring wood, with its large cells, to autumn wood with small cells. Here and there you will find large openings surrounded by cells that are somewhat oval-shaped. These are resin ducts, lined with epithelial cells. Medullary rays can be seen running at right angles to the spring lines.

The preparation of wood specimens is not difficult. With a sharp plane set to cut very thin shavings, you can obtain all the longi-

tudinal sections you want. With a sharp razor, you can shave off very thin slices, either with or across the grain. Wood is easier to cut if it is soaked for several days in water; and you can produce thinner and more uniform slices if you use a hand microtome. (P. S. M. June '33, p. 33.)

If you have occasion to do a great deal of work with various woods, you will profit by building up a library of photomicrographs showing cell arrangements in various woods. These can be used for identifying doubtful samples.

Speaking of photomicrographs, it might be well to describe a stunt that seems not to be generally known among microscopists, including advanced workers. A camera that has no focusing back can be used to make photomicrographs with success. This opens the field virtually to everyone owning an inexpensive camera. The process is simple:

First, focus the microscope sharply while your eye is focused at infinity. This is not at all difficult because your eye normally is that way when you are studying a specimen. Now set your camera at infinity. If there is no infinity mark on the scale ("Inf." or oO), set it at 100 feet, because the average camera lens has its infinite focus at 100 feet and beyond. Place the camera, without removing its lens, in line with the microscope eyepiece, and provide some arrangement for keeping out stray light. The lens should be a fraction of an inch from the microscope eyepiece, say about one-fourth of an inch. Usually there is a reduction in magnification by this method, in comparison to a set-up employing only the microscope lens. However, the reduction is not great enough to interfere with the usefulness of the method.

This cross section of white pine, enlarged by microscope's lens, gives a good view of its annular rings and resin ducts

Your Microscope Explains Mysteries *of* Photography

POPULAR SCIENCE MONTHLY
DECEMBER, 1935

By Observing the Action of Developers and Films, You Can Learn How to Improve Your Own Work In Making Photomicrographs and Ordinary Pictures

By MORTON C. WALLING

The image of a face on a miniature photographic negative, magnified 130 diameters. It is made up of grains or clumps of finely divided metallic silver

WHETHER or not you are an amateur photographer, you can spend a fascinating evening investigating the mysteries of photography with your microscope. As a by-product of such exploration, you will become more expert at making photomicrographs. Or, if you have not yet ventured into this exciting branch of microscopy, you will learn that it is not a difficult field, and that you need not spend a fortune for equipment in order to take pictures of the wonders you see through your instrument.

In the photograph below, a drop of diluted developer, on the underside of a cover glass, is being placed over a piece of exposed or light-struck film. In this manner you can watch the developing process

The light-sensitive part of a photographic film consists of one or more thin layers of gelatin containing silver bromide. This light-sensitive salt is in the form of very small grains distributed throughout the film. Obtain a piece of old, light-struck film—almost any drug store or photographic dealer will have some out-dated film that he will give you—and examine it with your microscope. Even at 100 diameters you can see that the emulsion, as the gelatin-silver bromide mixture is called, has a grainy structure. To see the forms of individual grains distinctly requires 1,000 or so diameters magnification; but you can distinguish the grains plainly at much lower powers.

Cut a piece of film about the size of a cover glass, and lay it on a clean glass slide, under the lens of your microscope. Place on it a drop of diluted photographic developer, add a cover glass, and watch while the developer reduces the grains of light-struck silver bromide to spongy masses of metallic silver which, because of its finely divided state, is black.

In watching this bit of microchemistry, you are witnessing one of the most important processes of the modern world—the conversion of a chemical compound into one of its elements, in such a way that it forms a photographic image. If you could observe grains of silver bromide which had not been acted upon by light, you would find that the developer does not reduce them to metallic silver. Further observation would reveal that the extent of reduction depends on the amount of exposure to light.

Because development begins immediately, observe the action of the solution as soon as possible after it touches the film. Time can be saved by putting a drop of developer on the cover glass, inverting the glass, and placing it so that the hanging drop covers the

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film over an area within the field of view.

With a concentrated-beam light source, such as the 108-watt lamp described in a former article of this series (P. S. M., Sept. '34, p. 44), you can see very easily why photographers are likely to become gray-headed in hot weather or tropical climates. Focus the light beam until it forms a small, bright spot on the image plane. Then, placing on the slide a piece of film which is either developing or has been developed and wet with water, watch what happens. At 100 or so diameters, you will see the mass of silver grains suddenly start moving. They flow about, like sand grains in a swift stream, or like the insides of an amoeba. What is happening is simply this: The gelatin melts in the heat of the light beam, and starts flowing. The same thing happens in many a developing tank that is too warm, or in an enlarger when attempts are made to enlarge a wet negative.

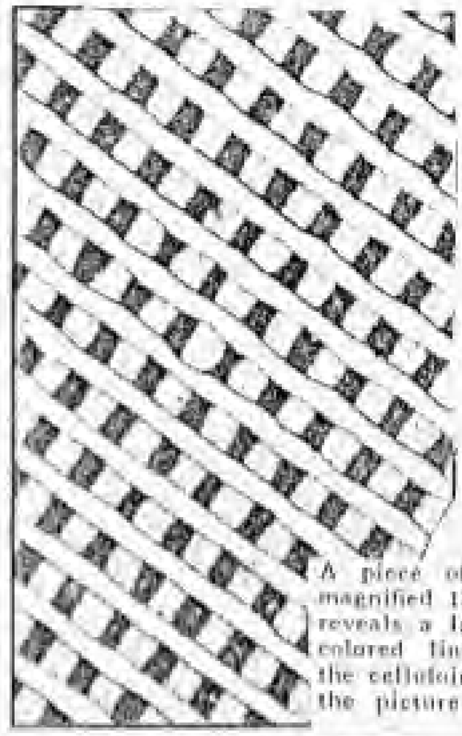
Sometimes, you will discover that some of the grains are moving, but that above them there is a layer remaining stationary. This indicates that you are looking at a double-coated film or plate, and that the gelatin of one layer has melted while that of another remains intact.

Mix an ounce of formaldehyde (the standard forty percent kind) in ten ounces of water, and put a piece of film in it for fifteen minutes. Now try to make the gelatin flow in the heat of the lamp. You find it impossible, or at least difficult. Thus you have discovered another important photographic trick: harden the gelatin of your films or plates with formaldehyde, before development if you wish, and you will not be bothered much by hot weather, photographically speaking.

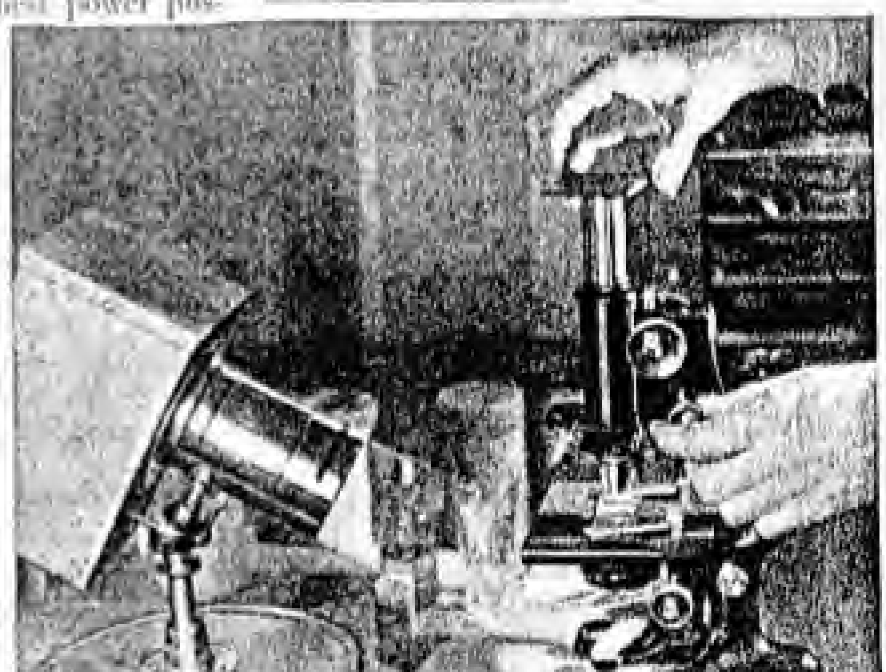
During the past few years, since miniature cameras have become so popular, a lot has been said about fine-grain development, fine-grain negatives, fine-grain enlargers, and even fine-grain prints. To the microscopist who ventures into photomicrography, fineness of grain is just as important as in miniature photography. In fact, the miniature camera and microscope frequently work together; and this teamwork is possible only because fine-grain negatives can be made.

Procure several old negatives. Get, if possible, a negative developed in the well-known pyro developer, and another of the miniature-camera type, developed in a fine-grain solution. Also, obtain one developed at a commercial finishing plant, and so on.

Examine these bits of film with your microscope, using the highest power possible without losing too much resolution or detail. You will find, upon comparing the grain sizes, that there is a vast difference. A negative developed with pyro (pyrogallic acid) has grains that are, relatively speaking, as big as oranges, when compared to the pea-size grains of the



A piece of color film, magnified 120 diameters, reveals a latticework of colored lines ruled on the celluloid base, as in the picture at the left

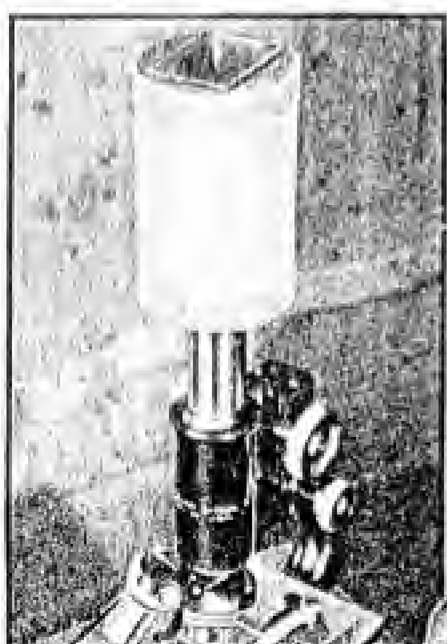


By concentrating an intense beam of light on a piece of wet film, as shown above, you can observe the effect of heat on the gelatin coating

carefully developed miniature negative.

Such microscopic examination of grain can be employed with advantage in any darkroom, particularly where extreme enlargements are to be made. After all, the ultimate size of an enlargement is limited to a large degree by the size of the grains of silver in the negative. Checking the grain of a miniature negative or photomicrographic negative may reveal troubles other than those resulting from the use of a certain developer. Overexposure, too high a temperature during de-

HOW TO MAKE A
Camera for Photomicrographs



The eyepiece of the microscope is passed through a hole in the lid of the camera attachment to mount it

The focusing box, with ground-glass screen, fixed on a microscope

A piece of motion-picture film being inserted in the pill-box camera. The knife is needed to guide the curling film through the slots in loading

The cardboard shutter is put together as shown at right. Note slot for the shutter arm, in the cylindrical box of the camera

The microscope is the most accurate means of detecting film faults, determining their cause, and studying the action of developers. Here the grain of a movie film is being checked

velopment, improper drying—these are some of the other things that may cause excessively large grain

Incidentally, photographic experts generally agree that the grainy nature of a negative is due to clumps of grains rather than to individual grains of silver. If the clumping action could be prevented, grain would cease to be a source of worry.

With this introduction to photography as the microscope sees it, you will find it fascinating to explore in other directions. Have you been having trouble with frilling or reticulation? That is, do your negatives have that patent-leather look that every miniature-camera user, and many large-camera fans too, dread during hot weather? Examine a reticulated negative with your microscope, and you will find that the gelatin coating is full of tiny cracks or folds, formed when it contracted or expanded during a sudden change in temperature. Such reticulations are, of course, undesirable because they play havoc with the image when attempts are made to enlarge more than three or four diameters. Sometimes, no satisfactory print can be made at all.

WAYS of avoiding reticulation include keeping the temperatures of all developing, rinsing, fixing, and washing solutions the same, generally between sixty-five and seventy degrees F. Another way is to harden the film in formaldehyde, as already described, either before development or at any other point during processing, so long as trouble has not already occurred.

You can have a lot of fun, and learn much about photography, by examining microscopically everything else in your darkroom or that of a friend. Natural-color films and plates are objects of dazzling beauty when seen at 100 diameters or so. Some of them exhibit a maze of colored starch grains; others show a fine network of colored lines. The various photographic chemicals—metol, hydroquinone, sodium sulphite, sodium carbonate, potassium bromide, hypo, paraphenylene-diamine, and so on—can be converted into beautiful objects for microscopic observation.

Simply dissolve a little of the chemical in warm water, place a drop or two on a clean slide, and set it aside until the water evaporates. You will find the slide covered with a network of beautiful crystals. Such crystals make unusually beautiful objects for dark-field and polarized-light examination. In handling metol and paraphenylene-diamine, particularly the latter, keep the solutions off your skin as much as possible. Some persons are susceptible to skin poisoning from these chemicals.

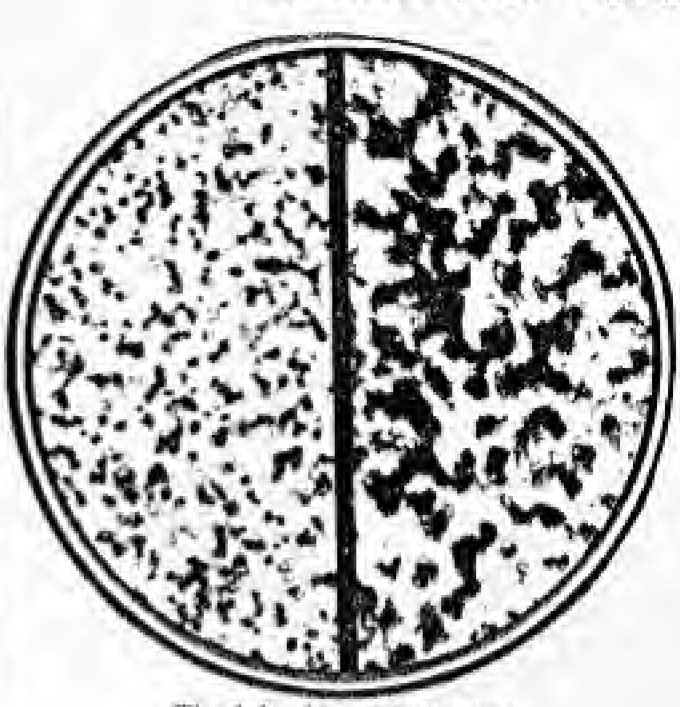
And now, since you have learned that it is possible to produce small, fine-grained negatives that can be enlarged many times; and have begun to suspect that there is really nothing very difficult about doing it, why not apply the knowledge to the making of photomicrographs?

"But I don't have the equipment," you object, "and photomicrographic cameras cost a lot."

Would you consider a dime excessive, for such a camera?

THAT is about the cost of a "pill-box" camera that can be attached to your microscope, and used to make excellent photomicrographs of just about anything that can be photographed with more elaborate equipment. The photomicrographs accompanying this article were made with such an attachment, which cost a total of nine cents.

Obtain from your druggist two cylindrical cardboard boxes about two and one-half inches in diameter and four inches long.



The left side of this photomicrograph shows a negative developed by fine-grain methods; the right half, by pyro

Stretch the lids slightly, until they will slip on or off easily, yet will not be excessively loose.

In the center of one lid, cut a hole of a size that will permit it to slip over either the upper end of the microscope tube, or the tube of the removable eyepiece, depending on the design of the instrument. It may be necessary to fasten a short length of cardboard tubing over the hole, so that the lid can be clamped in place on the microscope. With a standard ocular the fastening is simple. The ocular is pushed through the hole, and the knurled ring surrounding the upper lens clamps the cardboard lid against the end of the tube.

In the bottom of each of the two boxes, centered with respect to sides, cut a rectangular opening measuring fifteen-sixteenths of an inch by one and three-eighths inch. This is the picture opening, for this camera is to use thirty-five millimeters motion-picture film, the same as many popular miniature cameras and microscope attachments. Over one of the openings cement a piece of ground glass that is slightly larger all around than the opening, one and three-eighths by one and three-quarter inches being about right. Place the glass with the ground side down. Use ambroid cement, the same as is employed for model airplane making, for holding the glass in place, and assembling other parts of the attachment. You can obtain ground glass from a camera supply dealer, or make your own by rubbing one side of a piece of flat glass with a powdered abrasive, such as emery, mixed with water, using the bottom of a small bottle as a grinding tool.

THIS completes the focusing part of the camera. Fasten the lid to the microscope, invert the box and lower it into the lid, and you can focus the image of the object on the ground-glass panel or screen. Of course, there must be sufficient light coming through the microscope. A short length of cardboard tube, an inch or so in diameter and about the same length, can be set on the glass to make the image sharper by keeping out side light, if desired.

The other cylindrical box is the film holder. Lay a piece of thirty-five millimeter movie film about one and three-quarters inches long over the rectangular opening, and center it as nearly as possible. Mark along the edges and across one end. Remove the film and cement

strips of heavy paper or thin cardboard, whose thickness is but slightly greater than that of the film, along both sides. Across the marked end, cement a strip of thicker cardboard. Then, across the top, running from one side strip to the other, cement a rectangular piece of cardboard. This should be about one and three-eighths inches wide to match the length of the rectangular opening. Place it so that there is a narrow portion of the opening visible at the end where the cardboard strip was fastened. It is not a bad idea to cut a shallow V notch in the rectangular piece at this point. The purpose of the opening or V notch is to permit a knife blade or needle to be inserted for guiding the film (which has a tendency to curl) into place.

This arrangement forms a shallow slot, closed on the upper side by the cardboard piece, and having the rectangular opening beneath it. When a piece of movie film is inserted into the slot as far as the cardboard strip near the opposite end of the opening will permit, and excess film trimmed off with scissors, the camera is loaded. However, provisions must be made to keep out light until the exposure is made.

THE upper end (bottom of original box) is closed simply by pressing the remaining lid over it. The other end of the box is equipped with a simple cardboard shutter, which consists of a cardboard strip moving between two disks of cardboard having three-quarter-inch holes in their centers. One end of the strip projects through a slot in the side of the box, forming a handle. A common pin held in place with ambroid cement forms a pivot about three-eighths of an inch from the side of the box. Suitable strips of cardboard are placed so that they form stops for the movable strip, and spacers between the disks. The distance from the disks when in position, and the open end of the box, is just sufficient to permit the handle of the shutter strip to clear the edge of the lid attached to the microscope tube.

Paint the interior of the box, exposed surfaces of the shutter mechanism, and all parts of the film-holding portion, with black India ink, to prevent reflection. In fastening the shutter in position, first cement three or four pieces of cardboard to the inside surface of the box to form ledges. Then cement the shutter against the ledges, run a length of heavy cord around the crack between shutter and box sides, and apply a coat of black lacquer, asphalt varnish, or similar sealer to make the joint perfectly light-tight. Finally, mark the ends of the shutter-arm slot "shut" and "open," and your camera is ready to use.

YOU can use in it any type of thirty-five-millimeter motion-picture film, or other film cut to suitable size. However, there are several advantages in using positive motion-picture film for most work. This film is cheaper than negative stock. It is not sensitive to all colors of light, which enables it to produce sharper images, when used with microscope lenses not corrected for photography, than a material sensitive to all colors. Positive film can be handled by a Wratten safelight lamp (type OA), which gives an orange-yellow light. It produces a very fine-grained image even with ordinary developers. And, finally, it is fairly contrasty under most conditions, which is of advantage in photomicrography. Another excellent film, when red and orange color-sensitivity is desired, is quarter-speed panchromatic, which must be handled in darkness or by a special green safelight lamp. When yellow or green filters are used—these produce a sharper image with ordinary microscope lenses—orthochromatic film is best.

Although good results can be obtained by developing positive film in ordinary developers, the employment of a fine-grain developer is advisable for other negative materials. The so-called borax developers are moderately fine-grain in action. However, for the finest possible results, a paraphenylene-diamine developer occupies top position at the present time. Such a developer can be mixed as follows: Water (about 125 degrees F.), fourteen ounces; sodium sulphite, 585 grains; paraphenylene-diamine, sixty-five grains; and glycine, eighty grains.

Let the solution stand for at least twenty-four hours after mixing. Filter before using. It can be used over and over for several weeks, or even months. Develop twenty minutes at seventy degrees F. If the highly purified paraphenylene-diamine hydrochloride, known as PDH, is used, it may be necessary to increase, perhaps even double, the time. Keep this developer off your hands.

IN THE matter of special developers for positive motion picture film, the best course is to consult the manufacturer of the film being used. However, if you want to try a fast-working developer, which also is excellent for most printing papers, the following formula will be of interest: Water (70 degrees F.) sixteen ounces; metol, fifteen grains; sodium sulphite, one-fourth ounce; hydroquinone, fifteen grains; sodium carbonate, 200 grains; and potassium bromide, ten-percent solution, fifteen to thirty drops.

Develop until the image looks dense enough by transmitted light, which usually will require from one to three minutes.

Previous articles of this series have discussed the use of filters, substage diaphragms and other means of improving the operation of the microscope for making pictures.

YOU CAN UNCOVER THE Secrets of Photography WITH YOUR MICROSCOPE

By MORTON C. WALLING

POPULAR SCIENCE MONTHLY

AUGUST, 1938

PHOTOGRAPHY and microscopy often travel hand in hand, largely because the making of pictures through the microscope is a fascinating and useful activity. But there is another way in which the microscope and the camera can work together. Remember, the microscope was always a "candid" instrument. By using it as a kind of photographic accessory, you can draw on its power to make little things look big, and discover the hidden secrets of film, developers, and other materials of picture making.

You may be a camera bug to whom there is nothing more thrilling than running down some obscure trouble in a miniature-camera film. And again, you may not care a whoop about picture making as a hobby. But if you are a serious microscope enthusiast, sooner or later you will want to make photomicrographs. And you will produce better results if you first do a little exploring with your microscope of some of the important phases of photography. Besides, you'll find it a lot of fun.

Illustrated magazines are using natural-color photographs in ever-increasing numbers, both on the covers and inside. Some of these pictures fill almost a whole page. But, did you know that many, perhaps most of them, were reproduced from transparencies, that is, transparent colored films, measuring only about one by one and a half inches? Such enormous enlargement of tiny color transparencies without loss of detail is possible because the image is composed of dyes rather than grains of metallic silver. In other words, the image is practically grainless.

If you can obtain a color picture on 35-mm. film, the size usually employed, you can have a lot of fun examining it with your microscope. At fifty or so diameters, the detail remains surprisingly sharp and distinct, and with your microscope you can read obscure signs and observe other things that are difficult to see even when the picture is projected on a screen in the usual manner.

Photographers seem to worry about grain more than anything else, particularly if they are users of miniature cameras. Grain, in this case, refers to the particles of silver, or clumps of particles, forming a photographic image. Because of their small size and the necessity of subsequent enlargement to produce a useful print, miniature-camera negatives must be fine-grained. Various developers have been devised to keep the grain size down, although grain never is entirely lacking. The photographer who has a microscope can keep tab on the grain size of his negatives without the necessity or expense of making prints from them. All he has to do is clamp a bit of film on the microscope stage, with or without a glass slide to help support it, and examine the silver image at magnifications of 100 diameters and up. Only for extremely close study, such as study of grain shape, are powers as

Natural-color film transparencies are excellent microscope subjects. The dye images are easily studied

high as 1,000 diameters required.

In this way, the camera enthusiast can compare the grain produced by various developers, and select the one that suits his purposes best. He also can compare different films on the basis of grain size, and discover for himself the fact that positive motion-picture film developed in a coarse-grain developer usually has a finer grain than fast, panchromatic film processed in a fine-grain formula!

Sooner or later, every photographer, particularly the miniature fan, bumps squarely against a film "disease" known as reticulation. He will find that a prized film has a dull surface that, on close examination with the naked eye, looks somewhat like textured leather. When a print is attempted, the picture is found to be overlaid with a network of fine lines. Reticulation is most common in warm weather. Under the microscope, the emulsion (gelatin coating containing the silver salts before development, and the metallic silver image afterwards) is seen to be broken up much like the cracked mud on the bottom of a dried-up pond.

Careful examination at moderate power sometimes shows that the cracks are in only one layer of a double-coated film. The film frequently looks as if it were marked with innumerable, tiny folds forming a close network, instead of cracks. Care must be taken in making the diagnosis, for merely by shifting the microscope focus a trifle, reticulation cracks, which are lighter than the surrounding emulsion, can be made to change into dark lines that look like tiny ridges or folds. Such is the fickleness of light! Reticulation can be prevented by keeping the temperature of all solutions and the wash water the same—sixty-five to seventy degrees Fahrenheit.

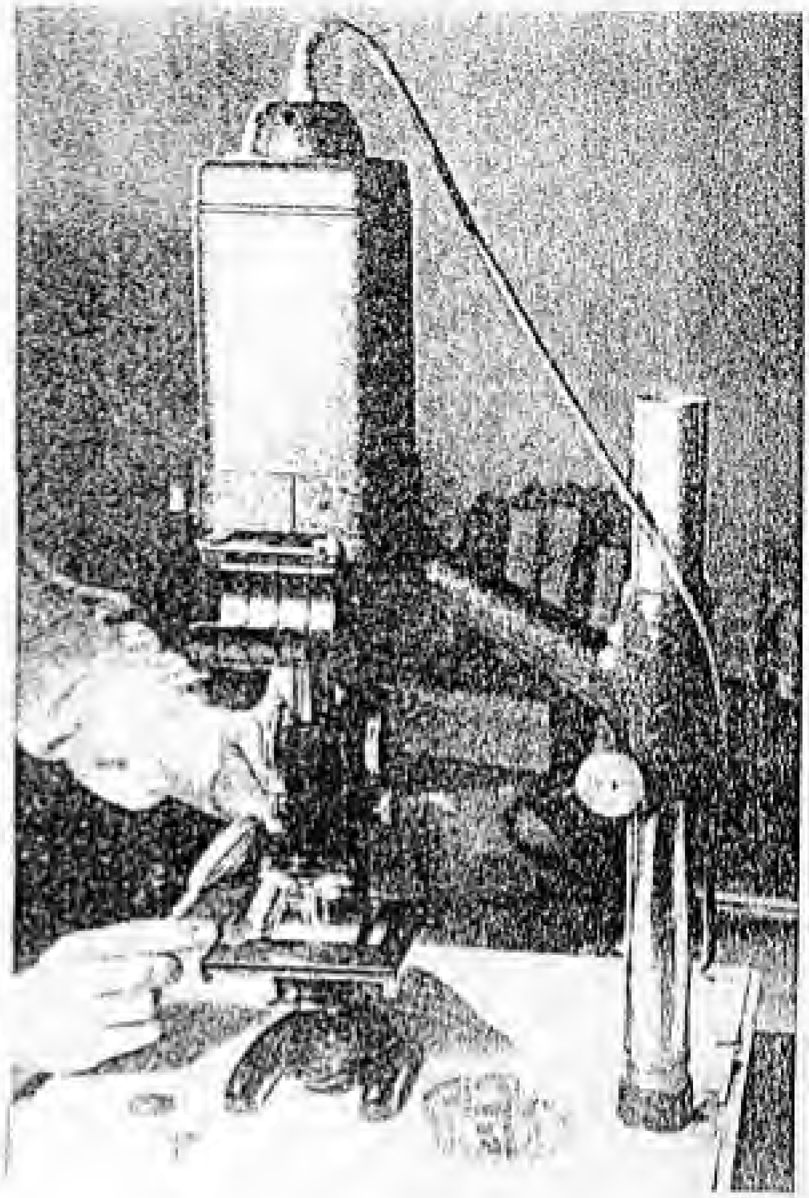
A stunt that will provide considerable entertainment for the

Right, film-negative emulsion showing "reticulation" caused by sudden cooling while film was wet. Below, how film developed with ordinary chemicals compares with that processed in special fine-grain solutions and with positive movie film

microscopist-photographer is the observation of film development through the microscope. Cut a small piece of film and lay it on a slide. Cover it with a clean cover glass, and focus your microscope on the film emulsion. With a pipette or medicine dropper, place a small quantity of dilute developer at the edge of the cover glass. Capillary attraction will draw it across the film, wetting the emulsion. Watch carefully all the time through the eyepiece, for development will begin quickly and proceed rapidly. Thus you can actually see the basic chemical reaction of photography —the transformation of silver bromide particles into tiny grains of metallic silver which, because of its finely divided state, is black.

A very useful stunt is to employ the lowest power of your microscope to examine the

At the left, a microphotograph, or tiny photograph, made on a glass lantern-slide plate is being mounted on a microscope slide. Below, solutions of photographic chemicals are placed on slides to evaporate, forming beautiful crystal patterns



For making microphotographs, a microscope is substituted for the lens of a photographic enlarger. A hand lens helps to focus the image upon the film

By placing some dilute developer on a piece of film on a slide, you can watch the developing process through your microscope

surface of a camera lens to determine its cleanliness, or the extent of scratches or other damage. If you cannot place the lens on the microscope stage, try holding it directly beneath the stage and focusing the microscope on it through the stage hole. Incidentally, this is also a good way to examine a microscope objective lens.

EVERY photograph reproduced in a magazine or newspaper is the result of a complicated series of photographic steps whereby the image is broken up into a series of dots of varying sizes which collect ink from the printing-press rollers and transfer it to the paper. By examining the half-tone reproductions in this magazine with your microscope, you can see these tiny dots, and observe how they vary in different parts of the pictures. Engravers who make half-tone plates for reproducing pictures, often employ a compound microscope to examine the condition of the dots and the progress of etching a zinc or other metallic plate with acid, and to make delicate corrections with sharp instruments, by altering the shapes of the dots.

Another possible use of the microscope in the amateur darkroom is as an aid in the retouching of miniature negatives. Usually, 1 by $1\frac{1}{2}$-in. negatives, or those of similar small size, are never retouched to correct such faults as pinholes—tiny clear spots resulting from dust on the film. However, with the lower powers of a compound microscope, sufficiently fine tools, and a steady hand, it is possible to perform certain alterations on a small negative. In watching the movement of the brush or other instrument through a compound microscope, remember that the image is reversed, so that you have to move your hand to the right to make the brush move apparently to the left.

MANY of the chemicals used in photography, such as pyrogallic acid and hydroquinone, produce crystals that make interesting objects for study. To prepare a specimen, dissolve some of the chemical in water, place a few drops in the center of a clean glass slide, and let it stand until the water has evaporated.

By removing the regular lens from a photographic enlarger and substituting a compound microscope, mistituting a compound microscope, microphotographs, which are extremely small photographs, can be made. Positive motion-picture film or lantern-slide plates are best for this, because of their fine grain. Suppose you are going to employ a $3\frac{1}{4}$ by 4-in. lantern-slide plate. With a glass cutter, reduce it to strips from $\frac{1}{2}$ to $\frac{3}{4}$ in. wide. Use one of these as a focusing screen by

placing it, coated side up, on the microscope stage. Place a negative in the enlarger in the usual manner, and focus the microscope until a clear but greatly reduced image of it is formed on the strip of lantern-slide plate. A magnifying glass is useful for telling when the image is sharpest.

Now turn out the enlarger lamp, and replace the lantern-slide strip with a fresh, unexposed strip. Starting at one end, make a series of exposures, giving each a different time. Develop, fix, and wash the strip in the usual manner. After it is dry, examine the images with your microscope, and select the best for permanent preservation. If the negative was placed in the enlarger in the proper position, the tiny microphotograph on the lantern-slide plate will be right-side-to when placed with the emulsion side down and examined through the microscope. With a glass cutter, separate the best pictures from the others, place a little balsam on the emulsion side, and mount them in the centers of standard 1 by 1½-in. slides.

YOU'LL always draw a laugh if you include one of these tiny photographs when you are showing your slide collection to a friend, particularly if the picture happens to be a likeness of the friend. Usually, observation of such pictures through the microscope should be made at the same power or a power lower than that used in projecting the image with the enlarger. Usually, also, the picture will show quite a bit of grain, in spite of the relative fineness of grain in lantern-slide plates or positive film. When observed at low or moderate powers, however, the grain will not be objectionable. This stunt, incidentally, should clear up a common bit of fog in connection with microscopy. Many people do not know the difference between a photomicrograph and a microphotograph. When you take a highly enlarged picture of a tiny object through a microscope, you are making a photomicrograph. When you reduce a photographic image, in the manner described, to produce a tiny positive print, you are making a microphotograph. When the microscope works in reverse, the words have to be reversed, too!

POPULAR SCIENCE MONTHLY
APRIL, 1934

Be a Detective with Your Own Microscope

By
MORTON C. WALLING

Trailing Hidden Clews and Identifying Many Unknown Substances Is Made Easy for Amateur

READY TESTS FOR PRESENCE OF STARCH

At left, how a specimen is taken from a potato in preparing to examine its starch grains. Below, using iodine to stain starch grains in flour so they can be examined more easily under the microscope

For dark-field illumination, arrange your light, as above, so it will strike the object obliquely. The cardboard is used to shield the eyes from light

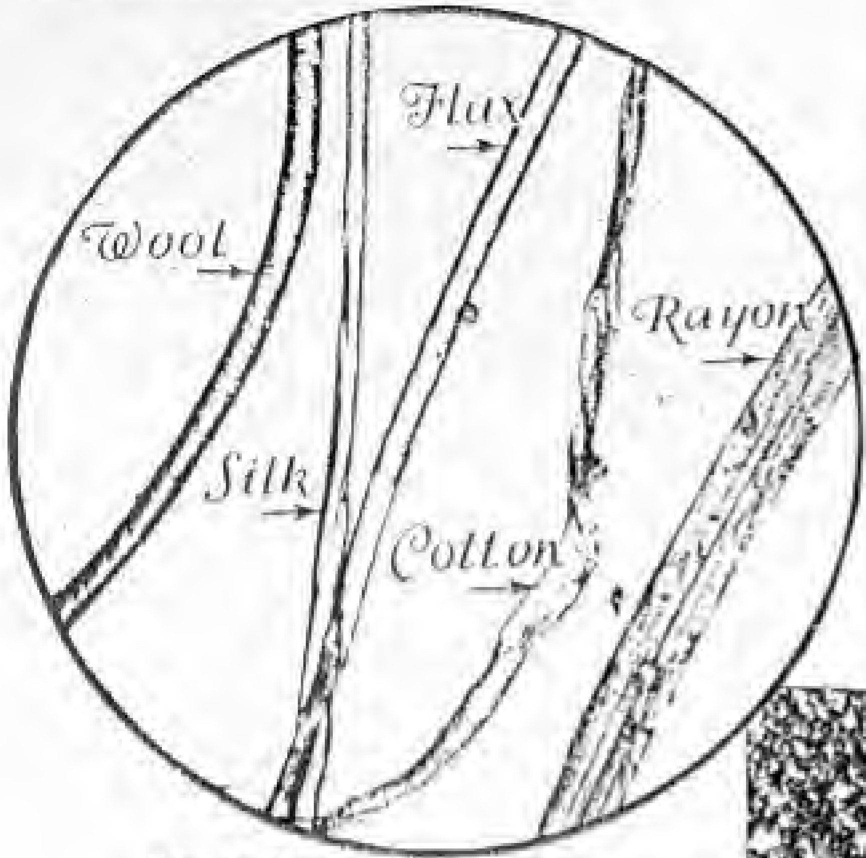
ALTHOUGH your microscope is an instrument of entertainment that admits you to a world of invisible wonders, it is capable of more serious work. As microscopes are used in commercial and government laboratories in examining and testing all kinds of materials, so you can employ your instrument for analyzing food, cloth, paper, and hundreds of other things found in your home.

It is fun to examine, at 100 diameters, a bit of fuzz plucked from your coat. At the same time, such an examination may show that you have been cheated, that the suit the merchant assured you was "all wool" really is a mixture of wool and cotton. In the same way you can learn, more certainly than in any other, whether many other articles are genuine or, in the case of food, whether it is fit for use.

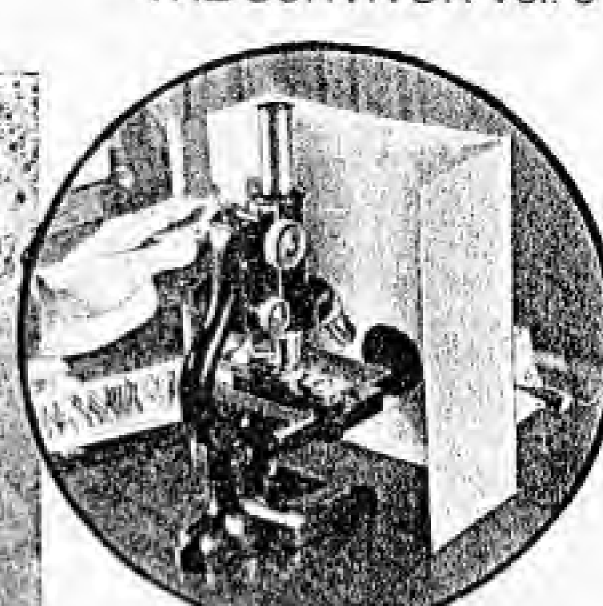
To be your own microanalyst, you need not possess elaborate equipment or be an expert scientist. Even the most highly-trained microscope specialists employ a system so fundamentally simple that anyone can follow it. Basically it is:

Compare the unknown substance with known materials until you find a perfect match.

Thus by looking through your microscope at specimens of cloth, starches, paper, foods, and other substances whose identity you know exactly, you soon learn to recognize these things when you meet them in strange places. It is like belonging to a club. You soon learn to recognize, on sight, all established members. Some

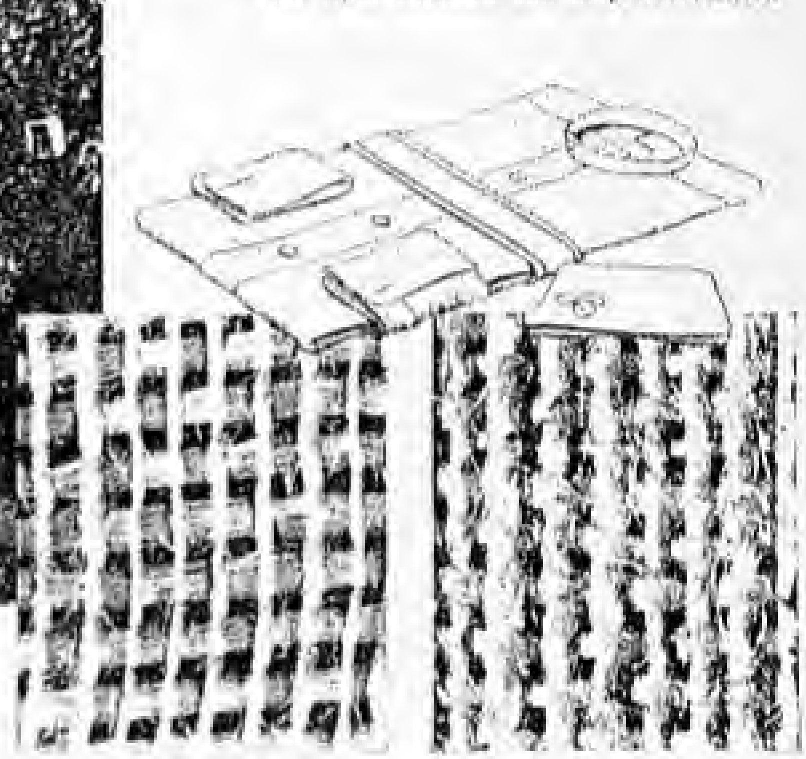


Here are the five principal kinds of textile fibers, each magnified enough to show its nature and help identification. A little study will make the differences readily apparent



A cardboard screen can be arranged around the microscope, as above, to keep the light shielded and help observation

Center top: salt particles in butter seen by transmitted light. Above, the same specimen as seen with a dark-field illumination. These two kinds of lighting are explained in text



Above left, shirt of rayon and cotton, and above right, shirt of linen. The threads of each of these three different fabrics can be identified if separated and viewed with a microscope

day you will encounter a stranger among the group of club members, but if you go about it in the right way you will not find it particularly difficult to identify him. Similarly, you can learn the identity of the strangers you find under your microscope by comparing them with known substances, with pictures, or by further observation.

When you first start out to discover the microscopic wonders of your home, and to learn whether your suit is all wool or whether the refrigerator contains anything that is not fit to eat, everything you meet will be more or less strange. Maybe you think that you already know all about the common things you will find—about a potato for instance; but soon you will discover that you previously knew almost nothing.

Here is a small Irish potato, a common spud. Look at it. If you can, by stretching your imagination, decide that it is an object of beauty, you deserve a medal, for you have rare insight. It *is* beautiful and interesting, but not as it stands. With a knife cut a small piece from the potato, scrape the surface until you leave a drop of cloudy liquid, and smear some of the liquid on a microscope slide. Into about one tablespoonful of water stir one drop of tincture of iodine. Add a drop of this mixture to the potato scrapings on the slide, and place a cover glass over it. With your unaided eye, you can see the smear take on a blue color. Now put the slide on your microscope stage and adjust the magnification to about 100 diameters.

Who said a potato has no beauty?

The bluish smear has resolved itself into a collection of nearly round jewels, sapphires they seem to be. They are not all of the same size, nor exactly of the same shape; but all are nicely rounded, with no sharp angles or ragged contours.

These particles are potato starch grains, colored blue by the iodine. This coloring action is a standard test for starch. You can add iodine water to any food or other material, and if there is starch present, the characteristic blue color will appear.

Examine one of the grains carefully, at a higher power if possible. You will discover that, like an oyster shell, it is made up of concentric layers. Near one end of the elliptical grain, you see what appears to be a dot or hole. This is the hilum, present in many kinds of starch. Potato starch grains are among the largest of any starch. Their surface markings are more distinct than on most other starches.

Make yourself well acquainted with potato starch, for you may meet it almost any place during your examination of household foods. Here, for example, is a sack of flour about which you know little or nothing. Is it pure? The microscope will answer that question if properly used, even when chemical and other methods might fail. Flour itself is composed largely of wheat starch, but sometimes the miller can make a greater profit by mixing some cheap potato starch with the flour. You cannot see the difference with your unaided eye; nor can you feel, taste, smell, or otherwise learn that there is a difference. But your microscope will tell you the truth at once.

Sprinkle a little of the flour on a glass slide and moisten it with a drop of the iodine water previously mentioned. Drop a cover glass over the specimen. Your microscope will reveal numerous blue particles, considerably smaller than the grains of potato starch, and more or less circular in shape. These are wheat starch

grains. Perhaps you can see the hilum and layers of one or more of the grains.

Here in the flour is a blue grain that is much larger than the others. It looks familiar, and you identify it as a grain of potato starch. You find others. The miller, apparently, has been cheating you. But before you complain to the grocer, inspect samples from several other portions of the sack of flour, so that you will get a representative picture. Then make sure that you can distinguish the various kinds of starch grains, by mixing potato scrapings and wheat flour together, and examining the mass under your microscope.

Because starch is one of the commonest materials used for adulterating granular foods, you must make yourself familiar with the other common forms before you can with certainty analyze foods. Leguminous plants, such as beans and peas, contain a starch that is different from other forms. The grains, usually elliptical in shape, have a slit-like hilum instead of the circular form found in wheat and potato starch. You probably will not be able to see the rings or layers.

Cornstarch, and that made from rice, are very much alike, but differ from other starches. Their grains are small and are irregular, with sharp corners and edges, and there is no visible layer structure. Grains of rice starch can be distinguished from cornstarch by their smaller size, and their tendency to clump together. Still another form of starch is that occurring in tapioca. The grains, about the size of those of cornstarch, resemble, for the most part, hard-boiled eggs from which a portion of the small end has been cut. That is, they are nearly spherical in shape, but have a flat place which projects a little. The microscope reveals a dot or hollow at the center of the grain.

Starches are not the only foodstuffs you can analyze with your microscope. Perhaps you have a sample of butter that you know little about. Smear some of it on a warm slide, and drop a cover glass over it. The microscope quickly reveals whether the butter is salty or sweet. If it is salty, the cubes of sodium chloride (table salt) will show distinctly, like crystal blocks. Pure butter is made up, for the most part, of small particles of fat and globules of water, evenly distributed. Butters which are composed partly of margerine or other fats and oils usually do not show such even distribution. The water globules generally are larger than those of fat.

Look at ground coffee under a low power, and you will be able to determine roughly whether or not it is pure. Among the materials used as an adulterant for genuine coffee are chicory, bran, burnt sugar and particles of the coffee plant. Small particles of coffee bean, under a high magnification, are seen to be made up of thick-walled cells containing tiny droplets of an oily liquid. The other substances used to cheapen coffee do not contain such cells. Chicory for example, has cells with walls that look fragile.

Sugar sometimes is adulterated with starch, and even white sand has been used, although rarely. You will have no trouble detecting starch by the iodine method.

Microscopic examination is an important means of controlling the purity of milk and cream handled by dairies. Usually the microscope is used to detect the presence of undesirable bacteria, and to indicate excessive numbers of white blood corpuscles which are produced by cows having abnormal or diseased udders. For such discoveries magnifications beyond the range of the average amateur microscope usually are used, and the preparation of test smears is an involved process. However, the dairy owner or farmer who wants to control the quality of milk and detect trouble at its source, might profit by a study of the subject.

There are scores of other foods that you can submit to the relentless eye of your microscope. Bread, bits of meat, cereals, tea, and many more will provide countless thrills as their wonders are revealed. In addition, they will be revealing to you their secrets of purity or impurity, and the other qualities that enable you to judge their worth.

THE general method of preparing foods for microscopic examination is to reduce them to small particles and perhaps mix them with water to form a paste. Thus tapioca starch is prepared by placing a few drops of water on a half-dozen grains of tapioca and crushing them (not too severely) with the back of a spoon. If the starch is being treated with iodine, the iodized water can be used to moisten the coarse tapioca grains. Do not use too strong iodine, or the grains will be too deeply colored.

One of the most valuable uses of the microscope around the home is the examination of fabrics. It reveals at a glance whether your shirt is wool, cotton, linen, silk, or rayon. Before it can do this, however, you must make yourself familiar with the appearance of these substances when magnified 100 or more diameters.

Wool cloth is made from the hair of some animal, usually the sheep. A hair has a definite structure and each animal produces a characteristic type. If you are familiar with the appearance of many hairs, you can identify the animal from which each comes. That is the method often used in criminal investigations.

But your suit or shirt is not a criminal, so you are concerned chiefly with the question of whether it is made of animal hairs or vegetable or mineral fibers. Obtain a piece of wool—material you know is genuine wool and nothing else—and separate a few of the fine strands from one of the individual threads. Place these under your lenses. An undyed hair is preferable for study. The hair, when sharply focused and properly lighted, looks like a shingled rod. If you slice it in two, at an oblique angle so that it is virtually split lengthwise, you may be able to see the inner structure. There is a central core or medullary layer of rounded cells. Around this core or axis is the cortex, made of flattened, elongated cells. Outside are the overlapping, shinglelike plates or cells. It is the interlocking of these sharp-edged, projecting plates that makes the wool fibers adhere together to produce a cloth of great strength and wearing quality. Once you have made yourself familiar with wool, you cannot fail to identify it wherever you find it.

COTTON, likely to be found with wool in cloth that is not all wool, looks like a mass of twisted ribbons under the microscope. Each cotton strand is composed of cellulose covered with a thin skin. Along the center of the strand is a canal. If you can shift a cotton strand about until the end is seen in cross section, you will find that the form is like a crescent moon or an ellipse. Twisting of the cotton fibers is perhaps the most outstanding feature by which they can be identified at a glance.

The other important fabric material originating from a plant is flax from which linen is made. A flax strand at one time was a bast fiber in the plant, that is, a fiber that grew on the inner side of the bark. The flax fiber, like that of cotton, has a canal along its center, but the cells making up the fiber can be seen.

The two silks, real silk and rayon, are as unlike each other as day and night, when seen under the microscope. Artificial silk is made by squirting cellulose in solution through fine nozzles to form long, even strands that are combined into threads. A typical rayon fiber looks like a jointless rod. Its surface generally is marked with parallel lines, perhaps put there by the edges of the die through which it was passed. Rayon fibers are larger in size, in some cases, than genuine silk or other fabric materials.

PERHAPS you will be surprised to discover that real silk strands have a distinct structure. The silkworm, in spinning the glistening thread from which its cocoon was formed, used two sets of glands. The two spinnerets of one set each produced a single, fine strand of silk. As these strands emerged, they were brought together and cemented by a substance from the second set of glands. Perhaps the silkworm long ago learned the secret of the stranded cable and its greater strength when compared with a solid rod of equal size. Anyway, a strand of genuine silk looks like a rod or cord with a central canal or partition running through it. The surface of a silk strand may not be perfectly regular, but marked by occasional ragged projections.

After you have made yourself familiar with the important textile raw materials, and have analyzed all the cloth in sight, you can have a lot of fun examining papers and determining their origin. First of all, make yourself familiar with wood and straw fibers. Paper is composed chiefly of wood, straw, linen, and cotton fibers. Newspapers are made of wood; fine writing paper of linen or cloth.

To prepare paper for examination, tear it into small pieces and boil it in a weak solution of lye (caustic soda) until you have a pulp. This process frees the fibers from the filling and sizing materials. Wash the pulp well in clear water, and with the microscope examine a portion of it either in the wet or dry state.

You will see, on some of the fibers taken from the paper, rows of round or oval pits or pores. You may be able to make out distinctly the individual cells, and observe that some are long and others short. The fibers, for the most part, formerly were fibro-vascular bundles in living trees, and the pits or pores you see on them were involved in water circulation through the tree.

THE habit of examining everyday objects is one that may prove of real value to you. By detecting a fraud—perhaps by discovering that a suit for which you paid an all-wool price really is half cotton—you may save more than the cost of your microscope.

You can have a lot of fun identifying various kinds of furs, although you probably will run into difficulty in obtaining authentic standard specimens. The family cat, junior's pet rabbit, and the local zoo are possible sources of comparison specimens. Another important and interesting field is the examination of furniture woods. Usually you will have no trouble in removing a small sample from some obscure part of a chair, table, or cabinet. The microscope is the easiest and sometimes the only way of positively identifying a wood. (P. S. M., Dec. '33, p. 44.)

By employing dark-field illumination, you can see things through your microscope that otherwise would be invisible or indistinct. To appreciate the advantage of the dark-field method, where the object itself seems to be emitting light against a black background, turn for a moment to astronomy. The stars are in the heavens in the daytime the same as at night, but you cannot see them because their feeble light is blotted out by the brilliant sky. At night the sky is black, the pupils of your eyes are dilated to admit more light, and the stars and the moon are clearly visible.

TO VIEW objects against a dark field, arrange the illumination so that no rays of light can pass into the microscope objective directly from the source of illumination. One way to accomplish this is to place the illuminator above the level of the microscope stage, so that its rays strike the object from one side. Another way is to place it below the stage, but to one side so that the rays pass obliquely through the object slide but do not strike the lens.

You can use the substage mirror to produce satisfactory dark field effects. Often by simply tilting the mirror until the light beam barely grazes the object and misses the lens entirely, good results can be obtained. Swinging the mirror to one side, so that the beam is still more oblique in relation to the slide, is necessary in other cases, particularly when higher powers of magnification are used and the objective lens is closer to the slide.

Many objects which are not particularly attractive by transmitted light (bright-field illumination) become things of great beauty when seen against a dark field. They stand out with startling brilliancy because of the greater contrast with the background. Dark-field illumination, for instance, will enable you to see the cilia or tiny hairs covering the surface of animals from stagnant water.

In using the dark-field method, remember that the objects being inspected must be scattered over the slide so that light can reach them from the sides. Use a low magnification at first, until you get the illumination properly adjusted. Dark-field work, and for that matter the bright-field variety as well, is best done in a darkened room. Then stray light will not fall on the stage, and your eye pupils will be at their maximum openings. If the room cannot be darkened easily, a light shield made from cardboard and placed around the miscroscope or stage, will help. Arrangement of such a shield is illustrated.

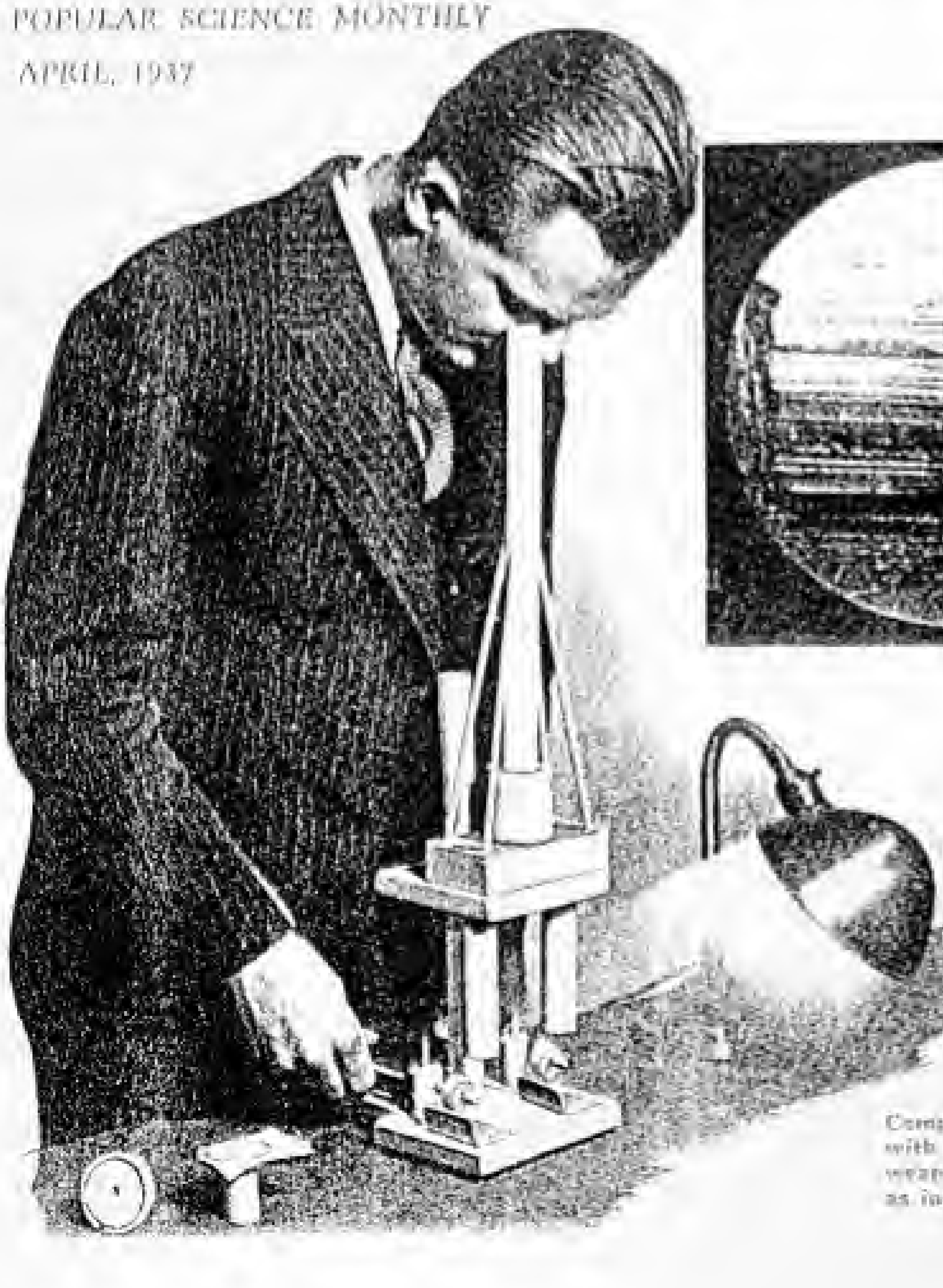
Suitable objects for dark-field study at low or moderate powers, include the salt grains in butter, rotifers in pond or aquarium water, grains of tapioca starch and other starches, parts of insects, and a million and one other things.

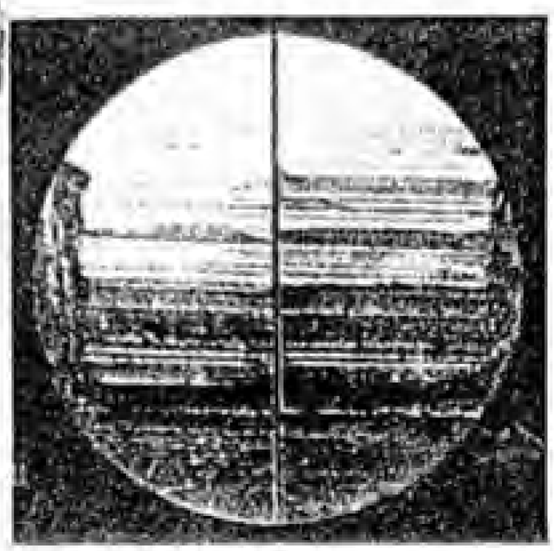
Homemade Detective Microscope

MATCHES BULLETS AND FINGERPRINTS

By *Gaylord Johnson*

POPULAR SCIENCE MONTHLY
APRIL, 1937





Comparing a "fatal bullet" with one from a suspected weapon. Images are joined, as in inset, to match grooves

TRACING a bullet to the rifle or pistol barrel that fired it, and positively identifying a "murder gun," is now a routine procedure in every well-equipped police laboratory in the world. Every reader of detective stories knows that gun identification is accomplished by comparing the grooves on test bullets, fired from suspected firearms, with the grooves on the "fatal bullet." But the apparatus needed for bullet comparison is supposed to be beyond the means of the amateur who would like to try the actual laboratory methods for himself.

High cost is, of course, unavoidable in the highly-finished and absolutely accurate "comparison microscopes" supplied to police laboratories. But the optical principles of the comparison microscope are very simple indeed. With material costing little more than a dollar, you can build an instrument that will give you the thrill of identifying bullets successfully. Also, your homemade apparatus will enable you to match up fingerprints, samples of handwriting, and typewriting, and any other objects that require careful side-by-side comparison.

Before we begin the actual construction of our homemade microscope, however, let us go over the general design of the accurate comparison instruments used

by full-fledged detectives. The professional comparison microscope, used primarily for matching bullets, is a double-barreled instrument, each tube of which carries an "objective" lens at its lower end. Each of these lenses is placed directly above the side of one of the two specimens to be compared. The usual practice in mounting bullets for comparison is to attach them with beeswax or modeling clay to the faces of little disks which can be slowly revolved by the fingers, while the eye watches through the microscope eyepiece for matching grooves.

A suitable arrangement of mirrors bends the rays coming from each objective, and combines the two bullet images in such a way that they form a single field, split in two by a narrow line. The grooves on the two bullets are thus made to meet, end to end.

When bullets fired from the same gun are examined, and one is slowly revolved, the grooves on the half fields eventually match and can be traced continuously across the two images. But if the bullets are not from the same weapon, no such matching position can be found for them.

Since the first essentials of any microscope are the lenses, we shall dispose of them first. Nothing more costly is required for the objectives of your double-field instrument than two of the ordinary "linen-counter" folding pocket magnifiers of the type shown in one of the illustrations. They are obtainable from any optical store for about fifty cents each. The single additional lens needed is obtainable from the ten-cent store for a dime. It is a simple hand magnifier about an inch and a half in diameter, and of about four-inch focus.

You can determine the focal length by looking through the lens at newsprint and noting the distance from the paper at which it shows the largest clear image.

The construction of your comparison microscope is shown clearly by the photographs and working drawings on these pages.

The model shown was constructed of the simplest materials, available anywhere. All that is needed are a few pieces of plywood, some one-inch and quarter-inch dowel rods, several thumb set screws, a couple of one-inch wing-nut bolts, some two-inch package-sealing tape, and a few bits of ordinary mirror glass.

The base and supporting pillar for the apparatus are made from a piece of the plywood with a section of one-inch dowel rod set into a hole and glued in place. Four thumb tacks, forced into the under surface of the base, form the feet of the apparatus.

Along the back of the pillar, a piece of quarter-inch dowel rod should be glued, to serve as a guide rail to keep the objectives in line with the objects to be examined.

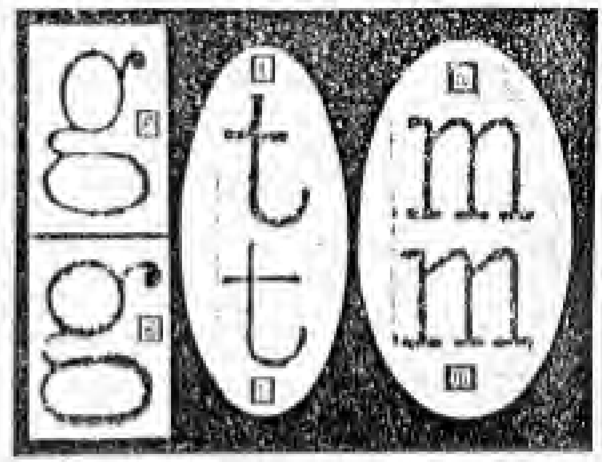
The bullet holders are constructed easily from short pieces of one-inch and quarter-inch dowel rod, and bits of cigar box wood. The upright cylinder of the bullet holder is fastened to the sliding supports by a flat-head screw so that it will turn with a little friction. The bullet-holder axle is also fitted to turn with a little friction in the hole in its supporting upright cylinder.

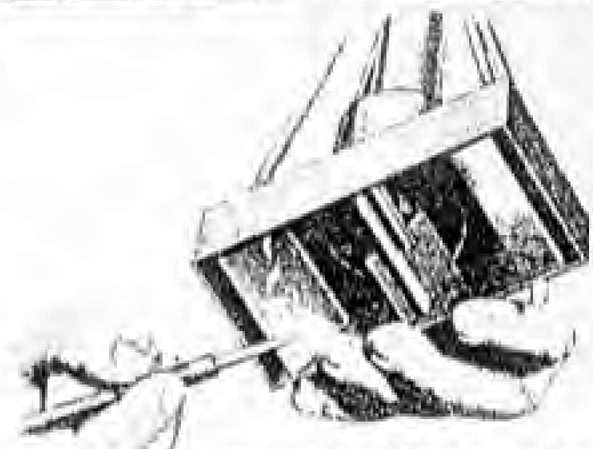
In the tops of these little upright cylinders, short pieces of quarter-inch dowel rod are glued, and these fit into holes in the cylinders of the circular "stages," which rest and turn upon the bullet holders below.

One purpose of these circular stages is to support and rotate discharged cartridge shells for comparison of the firing-pin and breech-block markings impressed on them when they were fired. Holes of suitable size to admit the largest shells to be examined are bored in the centers of the circular stages. Smaller shells are wrapped with paper until they fit the holes.

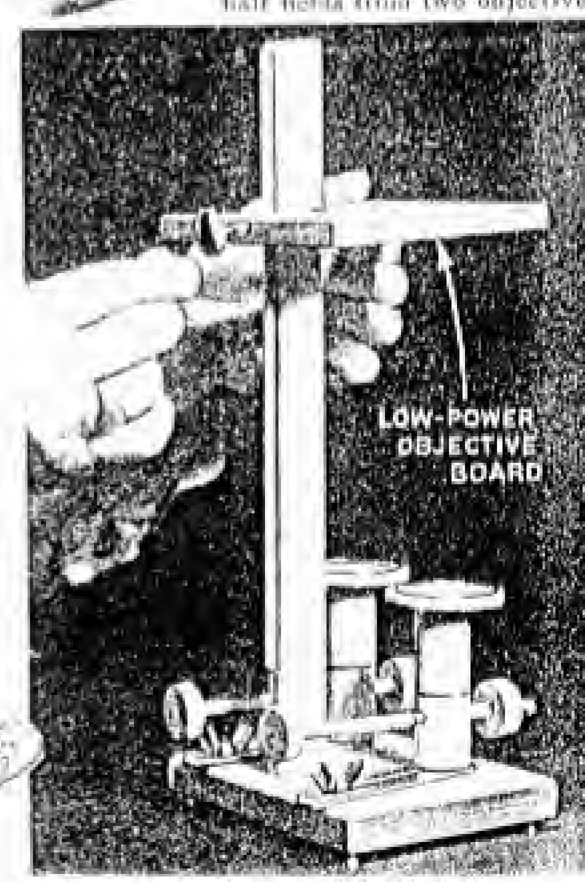
The other purpose of the circular stages is to support pieces of paper, glass, or other material which are being examined for the matching of the fingerprints they carry, or for comparison of samples of typewriting or handwriting.

The sliding members, thumb nuts, and axles of the bullet holders are provided to make it easy to adjust the bullets, finger-

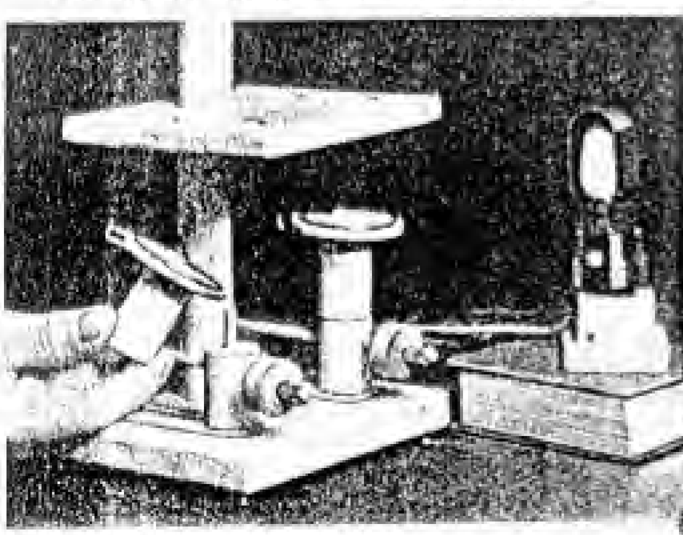




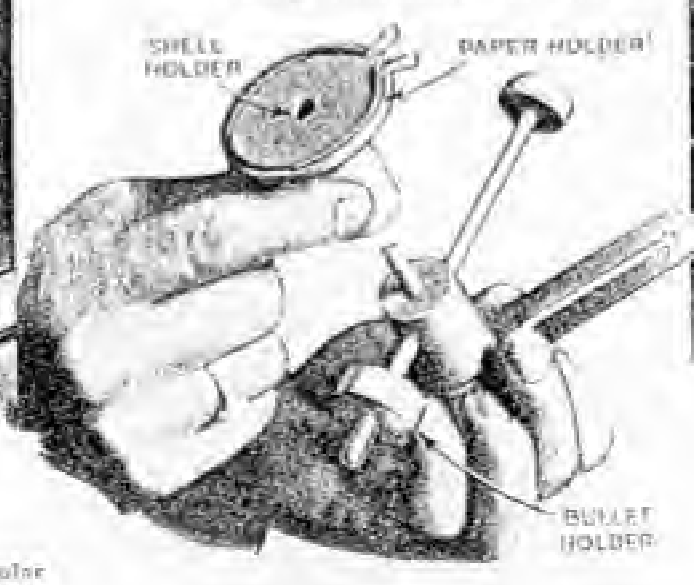
Underside of the reflector box, showing mirrors that unite the half fields from two objectives



For examining fingerprints, typing, and handwriting, a platform carrying three-inch-focus lenses is substituted for the high-power objective board that is used in comparison of bullets



Auxiliary stages are provided for comparing fingerprints, specimens of handwriting and typewriting, and other objects side by side



The picture at the right shows how the circular stages rest on pivots above the bullet holders

prints, and other objects directly under the objectives of the microscope.

The tubes to carry the linen-counter objectives are made by rolling pieces of gummed package-sealing tape around a piece of one-inch dowel rod until the required thickness is obtained. The first piece of tape applied is, of course, wound around the rod with its ungummed surface next to the wood. Moistened tape is wound around this, and the finished tube slipped off, and then cut to proper length.

THESE tubes are then fitted into the holes in the objective board, but are not glued firmly in position until the mirror box is adjusted in place above them. When the apparatus is complete, the objective tubes are slanted slightly until the two fields, seen through the eyepiece tube, join up in a straight line. The amount of slant is easily found by experiment, with the eye looking into the eyepiece tube.

Before the tubes are placed in the board, the linen-counter objectives are fastened to cardboard disks, pierced with quarter-inch holes, which are glued into the lower ends of the tubes. The folding stand of each magnifier must first be filed away from the square piece of metal which carries the lens. This can then be easily glued to the inside of the disk, with the lens coinciding with the hole.

This objective, together with the eyepiece lens above, gives a magnification of about twenty times, which is the one used in the best professional bullet-comparison microscopes. Its field is, however, too small for use in examining fingerprints or typewriting. For these purposes, an objective of larger field and lower power must be provided.

This is done by making a second "objective board" in which are mounted two lenses of about three-inch focus. These are obtainable also in ten-cent stores. They come provided with a paper cutter and rule as a handle, as shown in one of the photographs. This low-power objective board does not require paper tubes to support the lenses. These are fitted directly into the under surface of the board, and glued in place. This objective board is of course provided with a thumb set screw, and is interchangeable with the higher-power objective board. Quarter-inch holes are drilled into the upper surface of each to receive the dowel rod lugs fastened to the back of the mirror box and keep it in position.

The construction of the mirror box presents little difficulty. Simply cut the bits of mirror with a wheel-type glass cutter and build the mirror box as shown in the plan.

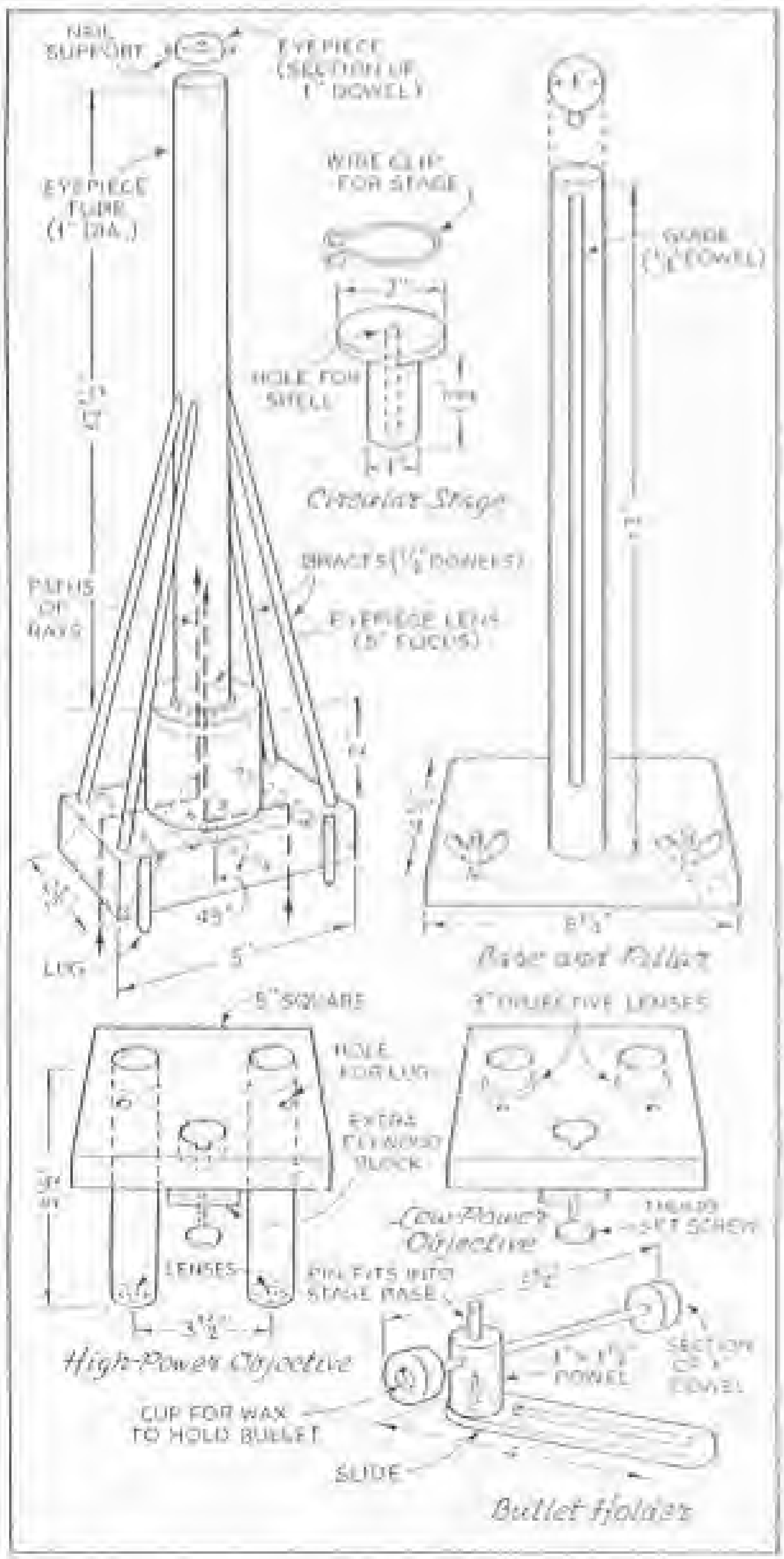
ONE point requires attention. After the mirrors and their supports are glued into their approximate position, fit the entire mirror box and eyepiece in place on the objective board, and focus upon some pencil crosses on paper under the objectives. You will thus be able to shift the mirrors slightly until the two half fields are equally illuminated. This is also the time to adjust the slant of the objective tubes until the two half-fields join up properly in the eyepiece and are both in sharp focus. When these adjustments are satisfactory, the parts should be glued and allowed to dry in position.

It is then a good plan to add four quarter-inch dowel rods as braces for the eyepiece tube, as shown in the photographs. Before adding these, you may find it necessary to slant the eyepiece tube very slightly to get the field well centered.

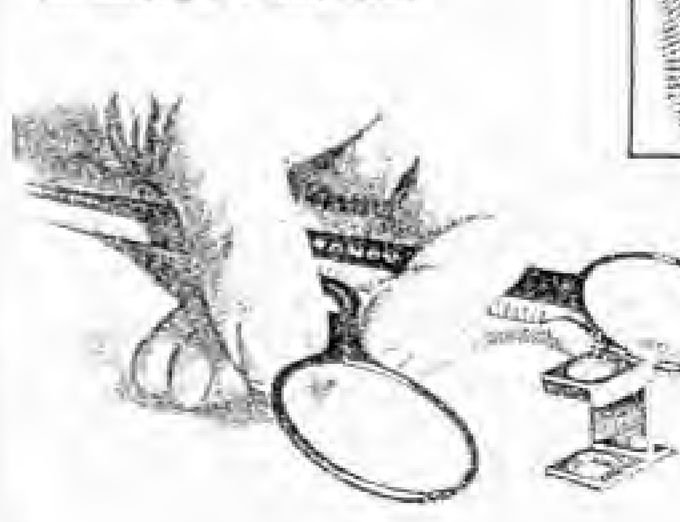
The small reflectors, which aid in illuminating the sides of the bullets away from the lamp, are made by bending two squares of bright tin or aluminum and setting them on the base of the instrument, as shown. The angle which reflects best is easily found by trial, and depends upon the height of the lamp used to supply light.

In using the circular stages for examining fingerprints, it is a good plan to make a spring clip of brass or iron wire, under which the paper can be held flat and in position. The ends of the wire can be forced into the underside of the circular stage.

In matching up fingerprints, the circular stages are rotated around their vertical axes. If the fingerprints on the two stages were made by the same finger, they can be joined up in the eyepiece, just as the bullet grooves can. You will then see what appears like a single complete print, but it will really be made up of the two half images contributed by the separate prints. If the prints were not made by the same finger, they cannot be made to match in the eyepiece.



Below are shown the inexpensive lenses used. The "linen counter" costs about fifty cents, the others just a dime apiece



Fingerprints, magnified to look like the one at the left, can be compared side by side. Below, differences in letters typed on different machines, as revealed by the lenses of the microscope

IN EXAMINING typewriting, the minute differences in the same letter of the alphabet, as written by machines of different makes, are easy to detect if the samples of typing are placed upon the circular stages and compared in the double-field eyepiece.

Peculiarities of individual machines—such as broken letters, tipped letters, and letters above or below the line—can be easily studied with the comparison microscope.

You also can cut out from handwritten letters common words like "and," "the," and "or," and study their characteristics side by side. This is an interesting thing to do whenever ransom letters are published in the newspapers during a kidnaping case.

Two hobbyists can have a lot of fun identifying "unknowns." An unknown is a sample of typewriting or handwriting, the authorship of which is unknown to the detective. To trace a make-believe ransom note to the one of several suspected typewriters on which it was written is a thrilling game, as well as good practice in actual, practical detective work.

When your comparison microscope is built, you will undoubtedly think of ways to use it in additional detective problems which I have not mentioned. It offers a field which has hitherto been closed to the amateur.

If you have a lathe, and sufficient patience and skill, you can build a much better-finished instrument than I have shown in the photographs. The object has been to explain the principles involved. The precise form of the construction is not important as long as these are observed.

Crime-Detection Stunts with Your Microscope

POPULAR SCIENCE MONTHLY AUGUST, 1937

With your own magic lenses, you can duplicate many of the tests that are employed to solve baffling mysteries

By
MORTON C. WALLING

Applying the iodine color test for starch

Starch cells from a bean, as seen by the microscope in the analysis of food

Microscope and illuminator fitted with polarizing disks for examining substances by polarized light. Right, starch grains identified by crosses under this kind of illumination

THE body of Silas Mercer was found sprawled on the floor of his bakery, near a machine used for mixing bread dough. His clothing had been torn and pulled out of place, indicating a struggle. Sam Bolton, a former boss of the bakery machine shop, was suspected of the crime. He and Mercer had had a violent quarrel two days before, when Mercer fired him.

But Bolton had an air-tight alibi. His landlady testified that she had seen him enter his room on the evening preceding the crime, and that he hadn't left until the police came to take him to headquarters for questioning. Yet Bolton was confronted with such damning evidence that he finally confessed, and explained how he had slipped out the window, climbed down a rain spout to get to the bakery, and then climbed back in again after he had killed Mercer.

The things that convicted Bolton were a few innocent-looking grains of wheat starch—and a microscope. When the police found the body, and saw that there had been a struggle, they immediately reasoned that the killer must have picked up some flour on his clothing. Flour contains much starch, so the logical thing to look for was a collection of starch grains. They found them when they had Bolton at headquarters, on the legs of a pair of pants he had left in his room. The department microscopist had examined the dust from the pants in polarized light, and had seen the characteristic pattern of light produced by each grain; he also had applied the iodine test which produces a blue color in starch. To answer the objection that Bolton might have picked up the starch grains while he was employed in the bakery, the microscopist found similar starch grains on the surface of the spout the killer had used for a stairway.

This relatively simple case illustrates one of the numerous ways in which the microscope can be used in solving crimes and in unraveling other mysteries. The amateur microscopist may never be called upon to help "crack" a murder case with his magic lenses, but that need not stop him from having a lot of fun in becoming

acquainted with some of the methods employed by present-day sleuths. Already you have seen how the amateur can make an inexpensive comparison microscope and use it for studying bullet markings, firing-pin impressions, typed characters, and other things that might be involved in criminal investigation (P.S.M., April '37, p. 68). While an ordinary microscope is unsuitable for such work as this, its owner still can delve extensively into microscopic sleuthing.

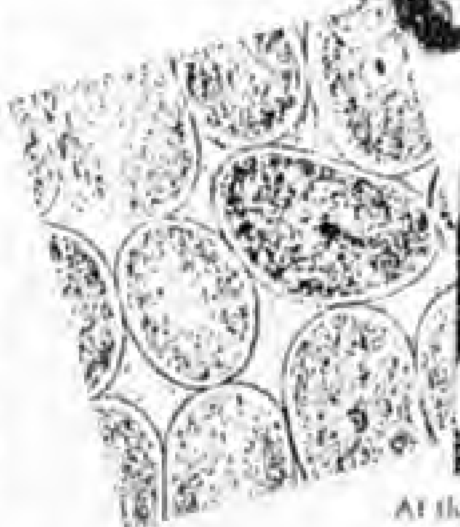
Among the easy investigations that he can pursue with his instrument are the identification of blood by examination of cells, inspection of blood crystals, study of vegetable tissues and fibers such as might be involved in the analysis of stomach contents, identification of hairs, examination of industrial dusts and metal chips, and study of paper and textile fibers.

The starch episode already described is an example of how an industrial dust might be involved in the solving of a mystery. When a crime is committed where such dust exists, and particles of the same dust are found on the bodies or possessions of persons who could not have picked it up unless they had been at the scene of the crime, the evidence is extremely strong. The microscope plays its part by magnifying the dust particles so that they can be identified by their form or by their reaction to various tests. Starch, a common dust, turns blue when treated with a weak solution of tincture of iodine. Even a half dozen grains under the microscope are more than enough to make the iodine test positive. Further checking can be done by examining the starch grains by polarized light, under which each will appear marked by a characteristic cross.

A yegg drilling a hole in a safe cannot help collecting some of the minute particles of steel on his clothing. Police can go over a suspect's clothing with an electromagnet and gather fragments for comparison with other steel chips found at the scene of the crime. Although the comparison microscope is useful for this, much can be done with an ordinary instrument.

If a murderer sharpens a knife or ax on a grinding wheel, it may be possible to link little globules or chips of steel found in his clothing with the steel in the death instrument. When you grind steel on an abrasive wheel, two kinds of particles are formed. In addition to numerous ragged, irregular chips torn out of the metal by the sharp abrasive grains, there are tiny globules formed when the sparks produced by grinding cool. These globules, for a given steel, assume characteristic shapes and appearances, which the microscope reveals clearly.

A professional comparison microscope in use. The photograph above shows how it compares a typewritten character with the same letter as made on a known machine, by joining parts of both in a split image



At the upper left are cross sections of human hairs. At upper right, a blond human hair, highly magnified. Right, mounting a hair in a special medium for testing

By studying known specimens until he has become so thoroughly familiar with their appearance that he will recognize them the next time he sees them, the microscopist can learn to identify various other kinds of dusts. Or, he keeps a collection of specimens on hand, which can be used for comparison purposes. This, incidentally, is the secret of most criminal-investigation work carried on with the aid of the microscope, and accounts for the fact that the Bureau of Investigation of the U. S. Department of Justice, maintains extensive collections of textile fibers, hairs, bullets, cartridges, typewritten characters, and the like.

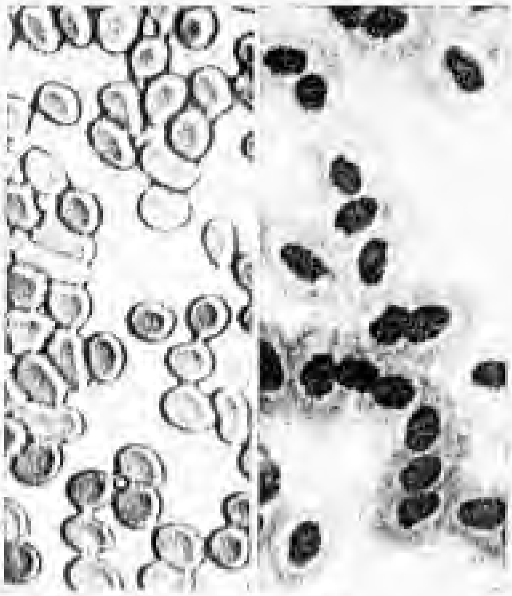
IT IS relatively easy for the microscopist to distinguish a human hair from animal hairs. Examine the hairs of mice, cats, dogs, and sheep. You will soon learn to identify the characteristic differences. You will see, for instance, that sheep wool has coarse surface markings, like a file. Hog bristles taken from a shaving brush, on the other hand, reveal no outer separate bark like that found in human hair.

There are an amazing number of things that the experienced eye can find in a hair by examining it through the microscope. It can classify that hair according to its color, surface markings, the race of the person from which it came, scales adhering to it, the way in which it was removed from the body, and the part of body from which it came.

When a microscope shows that a hair found under a murder victim's finger nails looks exactly like one from a sus-

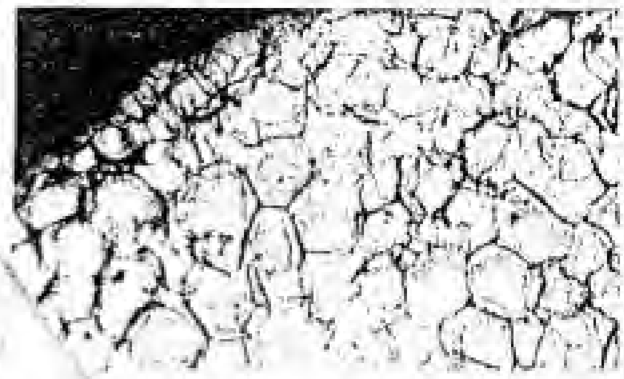
pect's head, there is almost no chance that the instrument is wrong.

Your examination of vegetable tissues and fibers—looking at the coil-spring walls of ducts and tubes in leaves and



Human blood corpuscles [left] compared with those of a cobra. The absence of nuclei in the corpuscles identifies the blood of a mammal

stems, examining the silica skeletons of plant parts, and observing the cellular arrangement of leaves—is a type of microscope work highly useful in criminal investigation. For example, it may be important to establish what a murder victim ate during the meal preceding his death. By analyzing the contents of the stomach and intestines, a skilled microscopist can tell with amazing exactness just what was in that last meal. He does this by studying the microscopic structure of particles of food—either undigested, digested, or at some stage between—found in the body.



Pith cells in a lilac stem that was stained blue with a common textile dye. Left, mixing dye

TEXTILE DYES as MICROSCOPE STAINS

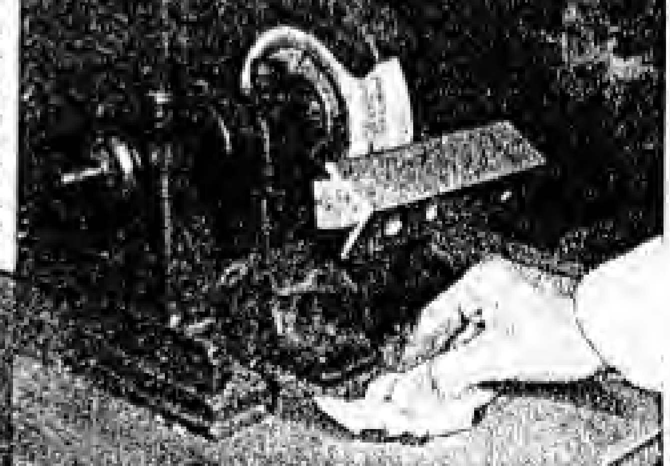
ORDINARY household textile dyes, available at drug and department stores, often can be used effectively as stains for microscope specimens. Determining the ways in which you can use them will provide an interesting and inexpensive research problem. Bright blues, reds, and greens generally give the best results; try mixing them together in different ways to produce various kinds of stains. One interesting project is to concoct a dye that will color cotton fibers but not silk, thus allowing you to test a "silk" cloth you suspect of being part cotton.

In most cases, the directions on the package will recommend that the dyes be used boiling hot, but this may be disastrous for delicate specimens such as thin sections of plant stem. However, dissolving the dyes in water will make solutions that are effective for many staining operations. Leave the specimen in the dye mixture until it has absorbed a deep color, and then rinse in water before drying and mounting in balsam. Many of the dyes also can be dissolved in alcohol or dioxan.

YOU will find it interesting to examine, with a microscope, some of the bits of solid material from vegetable soup or some other food preparation. Among the vegetables you can identify many familiar features such as the structure of cell walls. Beef and other meats show characteristic muscle fibers. To examine, say, a fragment of cooked cabbage leaf, tease it apart in a drop of water on a slide, and then add a cover glass. Examination of many kinds of leaves—celery, lettuce, spinach and so on—will demonstrate the ways in which they differ in appearance under the microscope.

Blood plays an important part in many crimes and mysteries. The microscopist can, by the simplest examinations, readily distinguish between blood and such materials as red paint, which might look like blood. The blood contains characteristic corpuscles, or cells.

To determine whether the blood is human or from some animal such as a horse, the microscopist examines the corpuscles more closely. The red corpuscles of mammals are in the form of circular disks, without nuclei. Red corpuscles from non-mammalian forms of animals, such as chickens, are oval in shape and contain prominent nuclei. Human blood can be distinguished from other mammal forms by measuring the diameters of the red cells with a micrometer attachment. Human corpuscles (red) range in diameter from about 1/3,100 to 1/3,500 of an inch, while those



A specimen of food under the microscope. Note the springlike duct walls, typical of certain vegetable tissues. At the right, a bit of food is being pulled apart preparatory to examining it for characteristic fibers and other features

Steel particles from a grinding wheel, picked up as above, may give valuable clews. The globules seen magnified at the left were formed by the cooling of glowing sparks of molten metal

of other mammal blood likely to be confused with human blood in criminal work are generally smaller.

BUT blood corpuscles cannot always be depended upon to furnish identifying details. Sometimes they have been destroyed by various agencies, so that they cannot be examined with a microscope. Then the little trick of preparing hæmoglobin and hæmin crystals becomes valuable. There are pronounced differences between the crystals prepared from human blood and those derived from the blood of other animals, so by making slides of the specimen being tested as well as of blood that is known to be human, it is easy to tell whether or not they are the same. The crystals can also be used to distinguish blood from other stains, such as ink.

You can make hæmin crystals without much difficulty. Place a little of the blood or fluid supposed to contain blood on a slide, add a small amount of common salt and a drop of glacial acetic acid, and heat to boiling over a flame. When the slide is cool and dry, add balsam and a cover glass in the usual manner.

A still more positive blood test is a chemical procedure that narrows human blood down to one of four type groups, making it possible to establish true parentage and solve other questions. This test is hardly within the scope of the amateur microscopist.

The identification of textile tissues is another important job for the criminologist's microscope. It is a relatively easy matter to make such identifications quickly and positively, once you have become familiar with the various fibers such as different kinds of wool, cotton, linen, silk, and hemp. Examination of the surface of a fiber is not always sufficient, and cross sections may have to be made.

IF YOU examine the fibrous structure of several different pieces of writing paper which may look alike to the naked eye, you will discover that they differ considerably. By soaking pieces of paper in water, perhaps treating them in a solution of potassium or sodium hydroxide (lye), you can secure individual fibers for examination. The identification of paper may be an important item in a criminal case involving forgery. The comparison microscope is used frequently for matching paper samples.

The microscopist who possesses a camera attachment for his instrument can make comparison studies of almost anything—typewritten characters, handwriting, bullet markings, cartridge markings, paper samples, steel particles, and so on—simply by making two photomicrographs, one of the known specimen and one of the unknown, and comparing prints or negatives by placing them side by side or one over the other. Of course, the magnification must be exactly the same in both pictures. This method is slower and more expensive than the procedure when a comparison microscope is available, but it is positive, and has the advantage that the results can be preserved indefinitely.

A FORTUNATE angle to much crime-detection work with the microscope is that it is done at low or medium magnifications. Examination of fingerprints, forged signatures, and the like can be done with a hand lens magnifying seven and a half diameters or thereabouts. The lowest powers of your microscope will suffice for much of the examination of vegetable tissues, metal fragments, and so forth. Higher powers are useful for studying starch grains, blood cells, crystals, and various hairs and fibers.

You can have a lot of fun by joining other microscopists in tracing down "clews" of various kinds with your instruments. You can stage a "crime," sprinkle some dust such as cornstarch around, and let your friends identify the dust. Or make as perfect a copy as you can of a signature, and then let someone determine which is the original writing and which the forgery. (The forged signature will show wavy lines, retracings, and other flaws when magnified a few diameters.) By such stunts, you can have a lot of fun, learn a lot about microscope technique, and get a taste of modern criminal investigation.

Microscope Detectives

By EDWIN W. TEALE

Solve Murder Mysteries with Aid of Clues too Small to See

POPULAR SCIENCE MONTHLY DECEMBER, 1931

GUST-driven rain was lashing the big elms in front of the country house in the New Jersey hills on the night David Winter was murdered. That fact, by a curious chain of circumstances, led to the single, astonishing, microscopic discovery that sent his slayer to the electric chair.

In the house at the time of the crime were a twenty-year-old nephew, the housekeeper, and a chauffeur who had been in the employ of the wealthy widower for many years. All declared they had retired early, leaving the old man going over his accounts by the fire. They had heard no unusual sounds during the night. Yet, the next morning, the housekeeper found the body of her employer slumped in his cretonne-covered armchair, his skull crushed by a blow from a bloodstained hammer that had been dropped beside him.

Taking charge of the case, a scientific detective examined the hammer handle. At a point where the first finger of a gripping right hand would come, he discovered a smear of dried blood. He studied it through a magnifying glass. There were no fingerprints. The murderer had worn gloves.

He demanded to see all gloves in the house. The chauffeur explained that his had been ruined the day before by acid spilling from the auto battery. Leading the way to the garage, he pointed out a pile of rags where he had thrown them. The detective rummaged in the pile, found the right glove, carried it to the light. His eyes narrowed. The entire tip of the first finger was eaten away with acid!

Apparently balked by this clever ruse, he raced to his laboratory with the glove and the hammer. There with a powerful compound microscope, he set to work. In three minutes, he had discovered an extraordinary thing, and in less than an hour, he held in his hands two dripping films, photomicrographs which solved the mystery of the murder and brought the killer to justice.

One film showed a magnified picture of a tiny elliptical spot where the wood

Ferdinand Watzek of Vienna, one of the expert microscope crime detectives of Europe

grain lay bare on the hammer handle. The cutter on the lathe had missed this spot due to a depression in the stock from which the handle was turned. The other film showed a similar ellipse packed with wavy lines, the magnified picture of an impression stamped into the palm of the glove when the slayer gripped his murderous weapon. The chance fact that it had rained and his gloves were damp made the impression, when seen under the microscope, abnormally clear. Placed on top of each other, the pictures matched like two prints from a single film.

LATER, the guilty chauffeur confessed that his employer had discovered thefts extending over several years and had threatened to turn him over to the police unless he made restitution. Planning his crime so there would be no noise, he had crept up behind his victim, while the storm howled outside, and had killed him with a single blow. By using acid to eat away the one stain on the finger of the glove, he thought he had destroyed all visible evidence of his guilt. He had. But invisible evidence, revealed by the magic of the microscope, tripped him up and brought a quick conclusion to his "perfect crime."

THE details of this remarkable case were told me by a crack homicide sleuth at the Scientific Crime Detection Laboratory, in Chicago. In talking to detectives using science to trap criminals in more than a dozen American cities, I heard of scores of similar drama-packed instances in which microscopes solved baffling mysteries through clues too small to see.

I was told of dangerous killers caught through telltale specks of dust and metal; of master forgers exposed by microscopic canyons in the dried ink of ancient writing; of clever cracksmen run to earth by scratches on metal one ten thousandth of an inch wide; of desperate gunmen jailed through the mute testimony of a minute raveling of thread!

When the Sherlock Holmes of today wipes the lens of his microscope, he is rubbing the Aladdin's Lamp of criminology. In almost every realm of crime detection, it plays its part. It scrutinizes dust and hair and fibers. It reveals spurious gems and counterfeit coins. It makes the scientific study of handwriting, typing, and printing possible. Fingerprinting depends upon it. And the amazing story of forensic ballistics, the study of markings left on fired bullets, could never have been written without its aid.

To help the work of the microscope sleuth, new equipment is constantly being devised. For night investigations, a Detroit concern is marketing a combined flashlight and magnifying glass and a New York manufacturer has developed a glass ringed with small electric bulbs. Powerful folding microscopes are available for field work; comparison instruments, with double lenses showing two objects overlapping for special study, are made in many sizes; and compound instruments that give 1,200 magnifications have been designed in compact form for use in makeshift laboratories. The tools of the trade now range from pocket glasses, smaller than a quarter, to a colossal apparatus, tall as a man and weighing half a ton.

This giant of the laboratory was devised by Luke S. May, famous in the Northwest as a scientific solver of mysterious crimes. It enlarges an object 5,000 times. When you visit May's laboratory in Seattle, Wash., and peer through the polished glass of this immense "magnascope," you see a human hair looking like a telephone pole, a speck of dust looming up like a massive boulder, and the finest stroke of a steel pen stretching like a wide black ribbon on a white background.

It was this "magnascope" that figured prominently in a strange bit of scientific crime detection a couple of years ago. On a lonely road near Tacoma, Wash., a nine-year-old child was found brutally murdered. The slayer had hidden in a blind which he constructed of branches cut from trees with his pocketknife. Police rounded up suspects.

TAKING their pocketknives, May carried them to his laboratory. One after the other, he clamped them in an elaborate mechanical arm which sliced the blades through branches at the exact angle at which one of the limbs used in the blind had been cut. The results, enlarged 5,000 times by the "magnascope," showed that one knife left identical marks on the wood. In addition, the giant lens of the laboratory revealed that the tiny tip of a fir

Dr. Muehlberger, of the Chicago Crime Detection Laboratory, who has helped solve many crimes by studying clues too small to be seen

1. With one blow of a heavy hammer the murderer struck down his victim, dropped the weapon on the floor and fled

2. His glove finger was bloodstained, so he stuck it in acid, thus destroying the clue and felt himself safe from detection

3. A microscope sleuth, finding the glove, wondered about that acid-eaten finger, and took the glove with him as evidence

4. In his laboratory he peered at the glove and hammer handle through a compound microscope and found a clue

5. Pictures showed how glove fiber had impressed itself on handle, bringing truth from suspect

needle, found on the clothes of the owner of the knife, exactly matched the remaining part of the needle found at the scene of the murder! A quick conviction followed.

Even more spectacular was another feat of this famous microscope-using criminologist—his brilliant work, a few years ago, in connection with the "Mystery of the Thirteen Matches."

A little after one o'clock in the morning, the wife of an Idaho mine official sat up in bed frozen with fear. She had been awakened by the stealthy creaking of a door. It was pitch dark. Her husband had been called away and she was alone in the house. She heard the intruder feel his way across an outer room and fumble in a cabinet where $600 had been hidden for deposit the following day. Then at the top of her voice she screamed.

THE frightened burglar, the money in one hand, blundered toward the window, mistaking it for the door. Then he struck a match, got his bearings, and rushed into the night before neighbors could arrive. The woman had not seen his face. The county sheriff, unable to find a single clue, gave up the case as incapable of solution. Then Luke S. May was called in. His first question was:

"Where did he strike the match?"

"There, by the window," he was told.

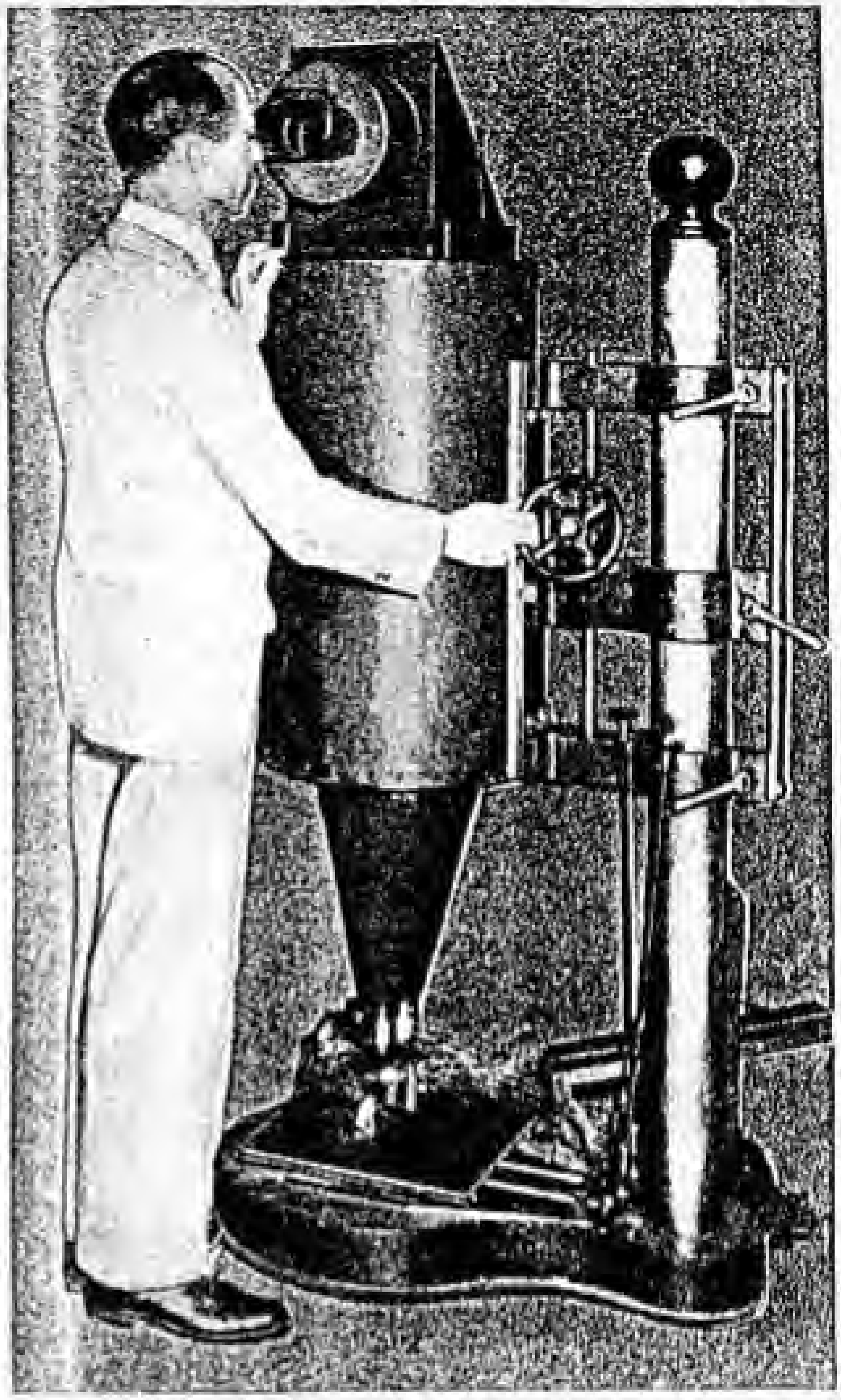
Everything had been left as it had been on the night of the burglary. Beside the window, two chairs were tilted against the wall. And on the floor beside them was not only one match, but *thirteen!*

On the evening before the robbery, the mine official and a friend had sat smoking by the window for hours, tossing used matches on the floor. May carefully gathered up the thirteen little sticks in his hand. Luck was with him. Twelve were grooved in the shafts. The thirteenth was round and crimped at the end.

"This is the one I want," he said, and turned to a powerful portable microscope. Under it, he studied the tiny stick. A minute stain of grease, a speck of coal dust, a glint of metal, a filing composed of iron and brass used in brazing, a particle of some strange fiber unlike any in May's extensive collection, told their story. Ten clues he found on the single match. Calling at the engine rooms of the seven mines in the vicinity, the detective learned a cylinder head had blown out at one on the day before the robbery.

"Where's the man who did the filing on that brazing job?"

A WORKMAN was brought in and from under his finger nails May scraped bits of coal dust and specks of iron-brass filings. He then stripped off the man's work clothes and revealed a second suit, of unusual make and texture. In the pockets he found matches, round ones crimped at the ends. Bits of fiber taken from the lining of the pockets proved identical with the mysterious thread particle discovered on the thirteenth match. Before they reached the sheriff's office, the captured thief confessed his guilt. Out of the 700 men in that Idaho mining town, May had picked the guilty one with a single match as his only clue!



Luke S. May, famous in the Northwest as a scientific solver of mysterious crimes, devised a magnascope that enlarges an object 3,000 times, revealing tiny clues

Because bits of dust and metal are so often vital to the solution of a baffling crime, special attention is being given to their study in the scientific crime laboratories of Europe and America. The famous French microscopist, Dr. Severin Icard, has just announced remarkable success in identifying the work a person is engaged in by studying the dust in his watch.

Granules of carbon, for instance, are always found in the watches of garage mechanics and coal workers, particles of metal in those of machinists, and grains of clay in those of masons. In the timepieces of barbers are tiny fragments of hair and in those of violinists specks of rosin.

In Germany, scientific sleuths of Berlin have made similar studies, analyzing the occupational dusts found in clothing. For months, one French detective analyzed the dust particles he discovered in the eyebrows of criminals, and another studied specimens found in the wax of the ears. Part of the laboratory equipment of the expert scientific detective is a collection of dusts for comparison purposes.

FOR justice often hangs on the testimony of these eloquent particles. In one microscope room where I spent hours watching these scientific crystal gazers at work, I saw layers of dust on a criminal's shoe analyzed to trace his movements. Particles of clay, specks of oily dust, shreds of decayed leaves, tiny bits of gravel with a diatom adhering to them, chaff and hayseed, gave a record that enabled the trained expert to reconstruct the path the wearer had taken. He was sure he had

walked on an oiled road, crossed a clay field, entered a wood, passed up the bank of a stream, and stopped at a barn. Such information in a score of cases has proved instrumental in breaking down alibis and placing a suspect at the scene of a crime.

Another dramatic phase of this battle against the criminal, in which gleaming lenses play a leading role, is the study of scratches and knife marks.

Not long ago, a scientific detective in the West traced a threatening letter to the sender by means of microscopic knife marks left on a lead pencil shaving! The bit of wood accidentally found its way into the envelope in which the letter was mailed. Photomicrographs of the infinitesimal grooves and ridges on the shaving corresponded in every detail with similar markings made by a jackknife taken from the pocket of a suspect.

IN RECORDING the markings left by larger knives, hatchets, and axes, the cutting tools are sliced through a block of beeswax, the cross sections of the block recording a perfect picture of the identifying ridges and grooves.

But scratches made by woodworking tools are not the only ones to give the trained sleuth illuminating clues. Those on metal are important, too. One day, when I was discussing this phase of the work with Colonel Calvin Goddard, head of Chicago's Scientific Crime Detection Laboratory, he said: "You can't make the same mark with a file twice." And that is true. Under the all-seeing eye of the microscope, the minute variations in speed, angle, and pressure become evident. Also, each tool, as well as each knife, leaves its identifying mark. Take a recent case in California.

A PAIR of clever lock breakers, preying upon telephone pay stations, had reaped a rich haul in towns along the coast. For six weeks they carried on their raids, opening the coin boxes with special punches and screw drivers and escaping before the thefts were noticed. Finally, police nabbed two young men in a Seattle, Wash., hotel. Hidden under the mattress in their room were punches and other tools. That was the only evidence against them, however—insufficient for a conviction.

A scientific detective was asked to examine the tools. Under his high-powered microscope, scratches on the last-robbed coin box and those produced by the confiscated tools jibed to the tiniest detail. In the space of an eighth of an inch, his lens revealed 100 major identifying marks, some only one ten thousandth of an inch wide! On the strength of this amazing, subvisible evidence, the two suspects stayed in jail.

Another dramatic phase of the work with microscopes was told to me by Dr. Herman N. Bundesen, then Chicago's crime-fighting coroner. A few years ago, police were on the trail of two of the most dangerous men alive, the red-handed gunmen, Scalice and Anselmi. These swaggering desperados of the underworld had killed a dozen men with their own hands.

ARRESTED in a taxi on Michigan Avenue, they grinningly submitted to search. No guns were found on them. But hidden behind the seat of the taxi, officers discovered a pair of loaded automatics. Jailed on a temporary charge of carrying concealed weapons, the gangsters maintained they had never seen the guns before. Their lawyer subpœnaed the records of the taxi company, proved eleven people had ridden in the same cab that day, declared any one of them might have secreted the weapons.

"How do you think we pinned the guns on the gangsters?" Bundesen asked me.

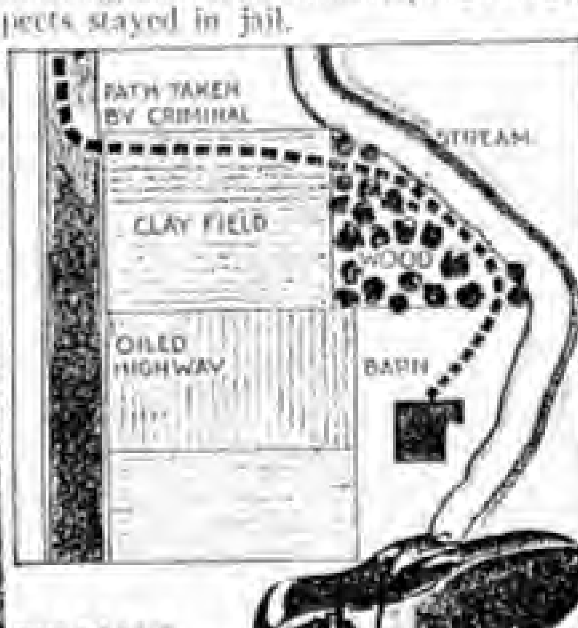
"By fingerprints?" I suggested.

"No. They were too blurred to be of use. But in the barrels of the automatics we discovered bits of fuzz, fragments of fiber from the linings of the pockets where they had been carried. We got the gangster's trousers and under the microscope compared bits taken *from* the pocket-linings with the fiber specimens found in the guns. We not only proved the weapons belonged to the gangsters but we knew which gun belonged to which man."

In order to aid sleuths in identifying strange fibers, Frank Gompert, of the sheriff's office in Los Angeles, Calif., has collected specimens from all over the world. His unique "fiber museum" is said to contain upwards of 200,000 samples.

I LEARNED that often the microscope is called upon to examine bits of fiber under strange circumstances. In an eastern city,

Detective Leddy, of the New York Police, using his glass in a study of the articles found in celebrated Snyder-Gray murder



TELLTALE DUST SPECKS

An analysis of the soil found clinging to the shoe of a suspect made it possible to trace in detail the exact path he had followed in going for some distance across the fields

A flashlight attached to magnifying glass for use in the darkness in the search for invisible clues

not long ago, a demonstrator for a company making bullet-proof vests sued his wife for divorce. Unfortunately, he failed to wear one of the vests he demonstrated in court. While he was testifying on the stand, his wife leaped to her feet, whipped a revolver from her purse and fired two shots. One went wild. The other ripped through the upper part of her husband's left lung. After a week in the hospital, it was thought he was on his way to recovery when he took pneumonia and died.

Had the shooting caused the pneumonia? That was the problem for the court. To find out, experts scraped the inside of the wound, made microscopic tests and found that fibers from the outer clothing of the victim had been carried into his chest, thus introducing the germs. The woman was held on a charge of murder.

Again, the versatile microscope plays a part in crime-solving by examining fibers and threads when fabrics have been cut or torn. Seen under a high-powered lens, a cut that looks perfectly straight to the naked eye appears as a jagged line. When the two halves are placed together, the thousand and one projections and indentations dovetail.

By this test, a murderer who wrapped his victim's body in a strip of canvas was run to earth. In another case, the revolver of a gunman was traced through a strip of tape wound around the handle. One end of the strip, under the microscope, matched the end of a roll from which it had been torn in the house of the suspect.

Paper fibers also often form a prize exhibit in the microscope-rooms of the crime laboratories. For instance, when a paper is creased the fibers are stretched at the point of the fold, and an expert, by examining a document at this place, can instantly tell if writing has been added after the paper was folded. Usually, the ink runs slightly where the fibers are pulled apart. Sometimes, on hard-surfaced papers, there is a microscopic gap in the ink line at the bottom of the crease where the pen has jumped over the "ditch."

While visiting one eastern handwriting laboratory, I was recently shown a "perfect forgery." A forty-year-old note, held against an estate, had been raised from \$10,000 to \$100,000. The shape, size, and formation of the forged figures and letters would have fooled the most expert eye. The ink that had been used was identical with the original. Yet, when I peered into the round lens of the expert's microscope, I saw an instant proof of fraud. The paper fibers had been swelling and shrinking with forty years of alternate dampness and dryness. As a result, the ink of the original writing contained tiny cracks. Lilliputian canyons that split open the black ridges forming the letters and figures. But in the newer, added, writing, there was not a single crack!

In a score of other ways, microscope enlargements reveal forgeries. They expose retouched spots on fake signatures. They reveal slips made in reproducing legal seals, in printing counterfeit bills and in making spurious coins.

Frequently, I was told, ace sleuths, in solving a crime, never go near the spot marked "X." They labor in their laboratories, painstakingly examining evidence submitted by trained assistants. In this manner, the late Dr. Albert Schneider, head of the noted Berkeley, Calif., crime detection laboratory, revealed the secret of a fiendish murder plot.

On a fall morning, shortly after nine o'clock, a number of people saw two men, a well-known chemist and a newly-hired assistant, enter the small laboratory where the scientist was conducting experiments with volatile liquids. Two hours later, neighbors rushed into the streets at the sound of an explosion. Livid sheets of chemical-fed flames streamed from the windows of the building. The fire had practically destroyed the structure before help arrived. Hacking their way into the smouldering ruins, firemen recovered a single charred body. Through vestiges of clothing found under it, and a ring on the right hand, it was identified as that of the chemist. His assistant had disappeared.

LIFE insurance companies, a short time before, had written large policies on the life of the scientist. They asked Dr. Schneider to make an investigation. From the back of the victim's head, where it had been partially protected by a soaked blanket, an assistant brought him three unburned fragments of hair. Another assistant obtained from the home of the chemist a hairbrush he had used. Combings from it were compared under a microscope with the fragments taken from the body. The results became instantaneous headline news.

The chemist's hair, Dr. Schneider found, was fine, round and straight. The fragments taken from the head of the dead man were greater in diameter and oval in shape, indicating the victim's hair was curly. To the trained eye of the detective, this evidence proved conclusively the dead man could not have been the chemist.

The papers announcing this sensational discovery were hardly on the streets before a flash from Portland, Ore., sent the presses racing again. In a downtown hotel, there, a stranger had committed suicide. He had been identified as the missing chemist. His written confession revealed the whole fiendish scheme, hatched to defraud the insurance companies.

IN HIS laboratory, the plotter had murdered his assistant, hired because he was his double in size and weight. Then he had placed his clothes and ring on the body of his victim. After pouring ether and carbon-disulphide around the body, he had escaped unnoticed, leaving a time mechanism to ignite the volatile chemicals.

With a host of such dramatic exposures to its credit, the microscope has proved itself the standby of the scientific sleuth. Its world of invisible clues is solving an ever-increasing number of baffling crimes. In the hands of the painstaking, scientific crime-fighters of the laboratory, it has become a major weapon in the offensive against crooks.

Colored Light Aids Your Microscope

By Morton C. Walling

A Simple Addition Increases Efficiency of Your Microscope When You Study the Tools and Activity of a Master Weaver

POPULAR SCIENCE MONTHLY NOVEMBER, 1933

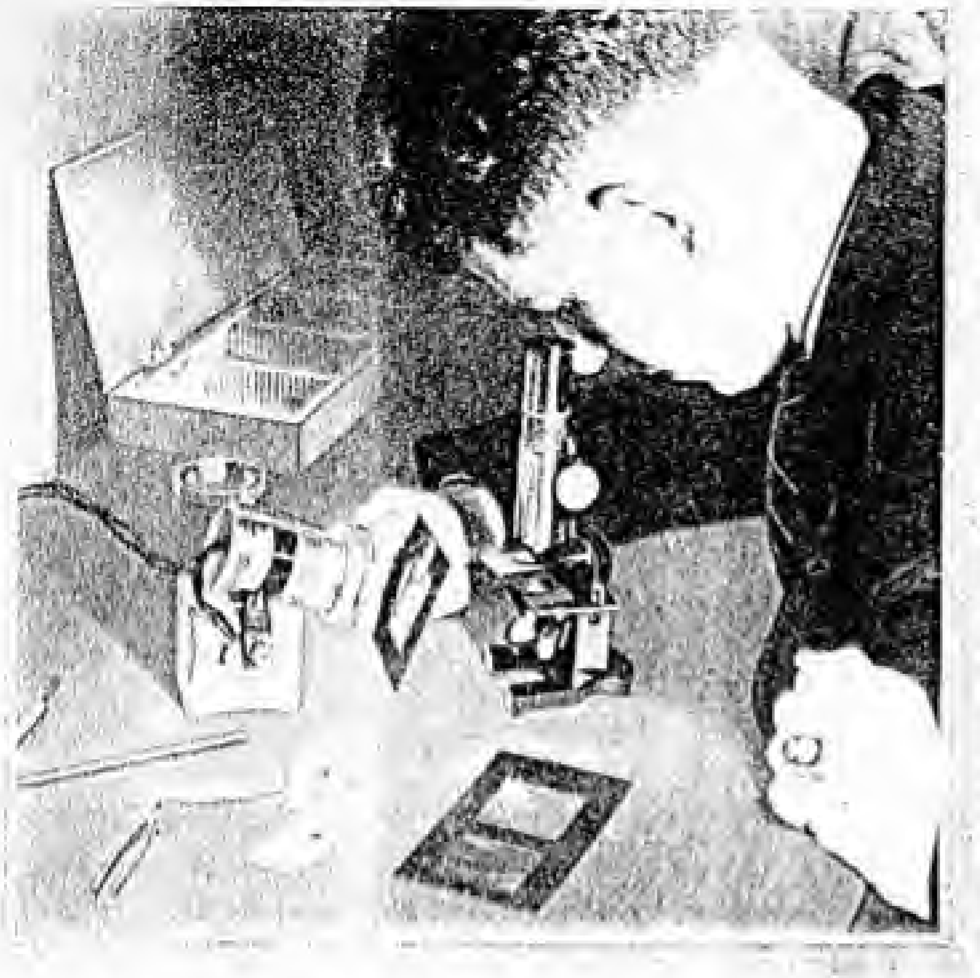
WHEN you leave the world of ordinary things behind and, with the aid of your microscope, go on an exciting journey into the Land of the Invisible, you find your trip enlivened by color. The green chlorophyll of plant tissues, the red corpuscles of blood, and the colored crystals are a few examples of natural coloring.

The most important thing about color in microscopy, however, is the fact that you can use it to help you see things that otherwise would be indistinct or invisible. If you make photomicrographs, you cannot escape for long the use of color.

The process of employing color to improve the performance of your lenses is so simple that you will encounter no difficulty whatever in applying it. You simply insert a piece of colored glass or other colored, transparent material into a beam of artificial light focused to illuminate the object you are examining. Sometimes you can use two or three colors at once. The colored glass is called a screen or filter.

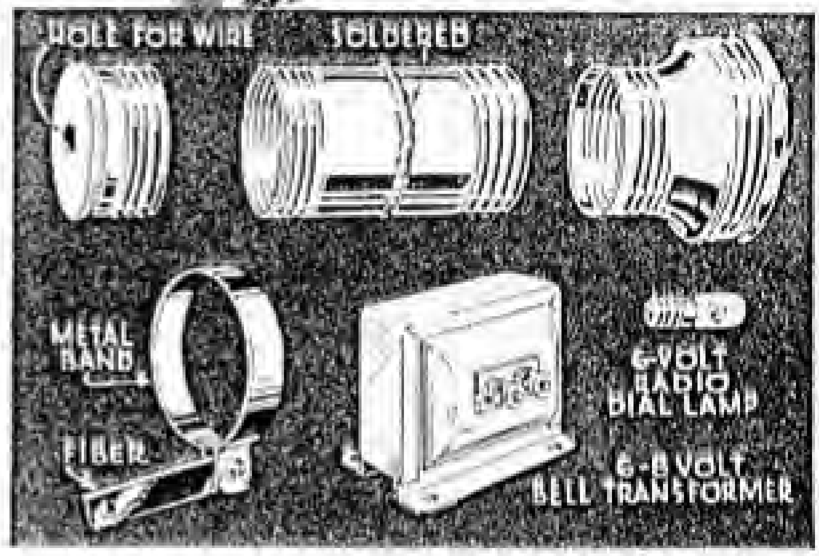
There are several reasons why a microscopist uses filters. For one thing, the lenses of many microscopes perform better in light of one color. Another reason is that, by using light of certain colors for illuminating specimens that have been treated with a dye, maximum contrast or detail can be brought out as desired. A third benefit lies in the fact that blue or green filters make long observations less tiring on the eyes. A fourth reason is that, in making photomicrographs, filters can be manipulated to control results. For instance, a section of yellow whalebone photographed by blue light would be rendered with great contrast, while red light would bring out the detail of the structure.

If microscope makers had but one color of light to contend with, their lives would be far easier. As it is, they must create lenses that are to be used in white light; and white light, as you know, is a



A colored gelatine filter is being held in the light path under the microscope to determine its effect. With a cheap instrument, a filter helps because an ordinary lens in a cheap instrument usually works better in the light of one color

In circle, the eyes of a spider, usually eight in number. In this specimen they are clear and brilliant. Below, diagram showing how to make an illuminator like the one at the extreme left



mixture of many colors each of which behaves differently when passing through a lens. Laboratory microscopes, having achromatic lenses, are corrected for two colors (with reference to chromatic aberration).

This means that the lenses bring two colors of the spectrum to sharp focus, while other colors are not so sharply focused. Higher-grade instruments, having apochromatic objectives, are corrected for three colors. As for the cheaper microscopes, it is doubtful if the lenses will bring more than one color of light to sharp focus at one point. The presence of color fringes about images indicates that perfect color correction is lacking.

The writer has a microscope that cost, when new, about $10. It magnifies to 125 times. Simple tests with a set of three-color photographic filters, that is, pieces of gelatine stained scarlet, green, and blue-violet and known to photographers as the "A," "B," and "C" filters, revealed that the microscope focuses all three of these colors at different points. When the image was rendered as sharply as possible by daylight, the insertion of any one of the filters into the beam of light falling on the mirror caused an apparent shift of focus. Refocusing would make the image sharp when the filter was in use. Then, if the filter were changed, refocusing was necessary. You will find that some filters, particularly when two of them are used together, absorb so much light that you may have to increase the illumination. On the other hand, filters reduce to a comfortable level the brilliancy of illumination that otherwise would be undesirable.

There are so many factors involved in the use of filters that no set of rules can be given in the space available. Color of the object being examined, correction of the microscope lenses, amount of detail or contrast desired, all must be taken into account. It is not always desirable to use a filter. A good microscope will perform well in white light. However, many microscopists find that pure white light is tiring to the eyes, particularly when they spend hours on end watching the antics of an active paramecium or rotifer. By inserting a blue or green filter into the light beam, such fatigue can be avoided or at least reduced.

Many microscopes come equipped with a blue viewing filter that slips into a holder below the sub-stage condenser. You can purchase blue or green filters in gelatine form or as gelatine cemented between glass. A flask of copper-sulphate solution, placed in the light beam, is preferred by some workers as a means of making the light easy on the eyes.

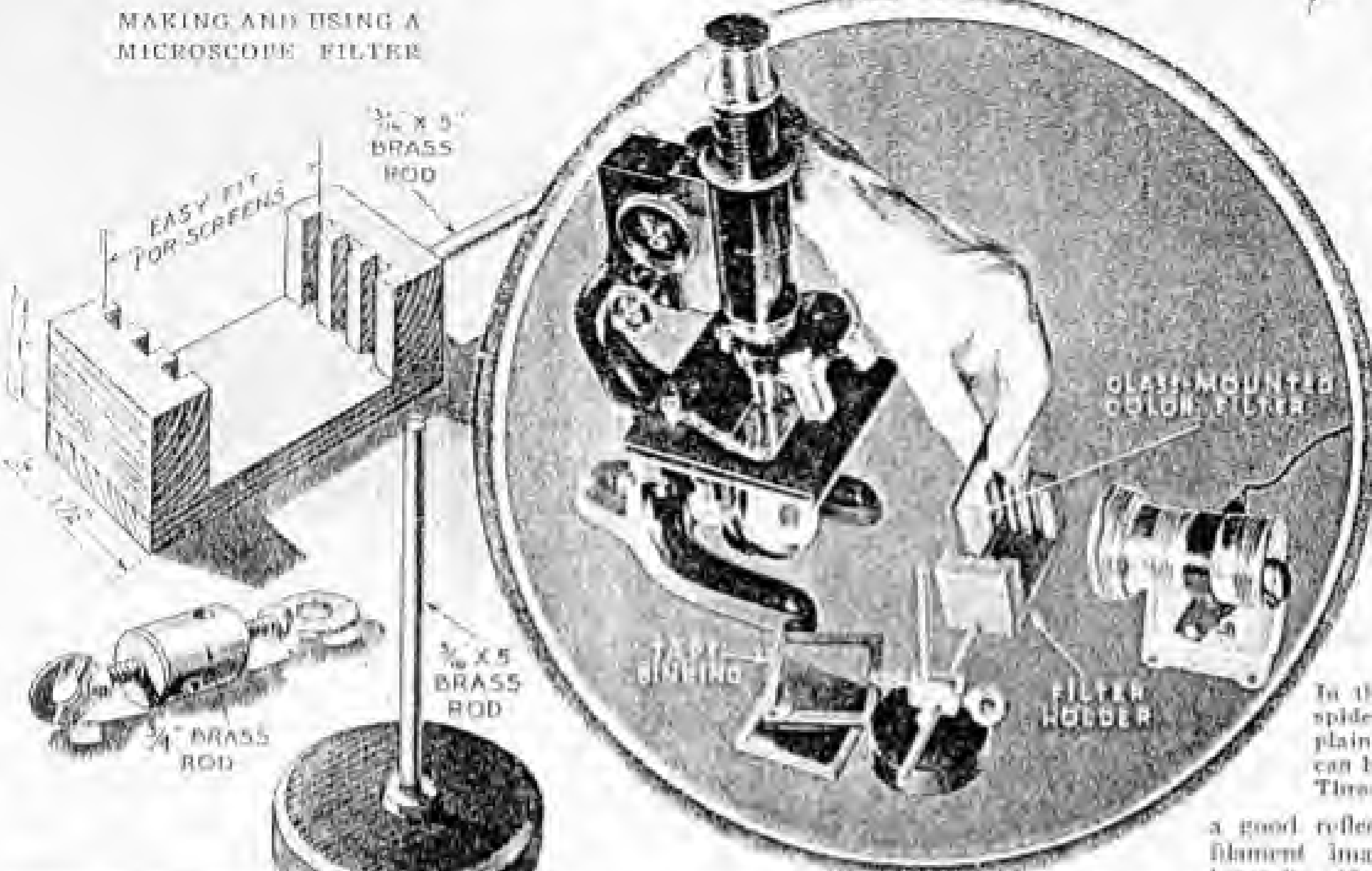
You need not go to a lot of expense to procure a set of visual filters. Although expert microscopists probably would shudder at the idea, you can build up a useful collection by procuring pieces of colored cellophane or similar material, bits of colored glass, and old photographic filters. Many store owners can give you pieces of the transparent material they use for coloring the light from their show-window illuminators. You can stain bleached out photographic plates or films with household dyes. Use either a plate that has not been developed but has been cleared in hypo fixing bath, or one that has been bleached by any of several methods, such as immersion in tincture of iodine followed by clearing in ordinary hypo solution.

At a cost of about ten cents per square inch, you can purchase special microscope filters in gelatine form. These are made by dyeing thin sheet gelatine. They must be handled with care because the gelatine will be damaged if touched with the fingers. Two- or three-inch squares of gelatine are preferable. There are a number of visual filters obtainable in this form.

In addition to the gelatine filters, you can buy numerous photographic filters. There is available a set of nine two by two-inch gelatine filters for photomicrographic work, at a cost of about $3.10. Most of these can be used as visual filters.

Filters made of gelatine, cellophane, and other fragile material should be mounted between glass or in cardboard frames to prevent damage when handled. A good way is to cut pieces of glass to a size about one-eighth-inch larger all around than the filter itself, and then sandwich the gelatine between two glass pieces whose edges are bound with lantern-slide tape. This method is satisfactory for all kinds of microscope filters because they

Below, at left, are the essential parts of a filter holder for your microscope. The base is a large pipe cap and the clamp was made from a piece of brass rod. In circle, filter of gelatine sheets between glass is held in the filter holder ready for use beneath the lens



In this picture of the shed skin of a spider, the fang on the chelicera is plainly seen. The fang is hinged so it can be folded down like a knife blade. Through its center runs a poison duct

The shed skin of a spider, which discloses much about the physical equipment of the creature, is here being arranged for study under a dissecting microscope

are placed in the beam of artificial light and therefore do not interfere with the light rays after they have left the object or passed through the lenses.

For holding the filters, you can construct a little stand that is adjustable to almost any position. Make a wood holder by cutting grooves in two blocks measuring about one and one-half inches long, one inch wide and five-eighths-inch thick. Cut the grooves about three-sixteenths-inch deep, and space them one-half inch apart, measured on centers. Fasten the blocks to a base piece five-sixteenths-inch thick, one and one-half inches wide and long enough to permit the filters to be slipped into the grooves or removed without binding. Walnut is one of the best woods to use for the holder.

Procure two three-sixteenths inch brass rods about five inches long, a piece of heavy iron such as a two-inch pipe cap, a piece of three-fourths inch brass rod one inch long or a brass bar of similar dimensions, and two stove bolts with washers soldered into the slots of their heads to serve as handles or grips for turning.

MOUNT one of the rods in the center of the pipe cap, and insert the other into a hole bored into the end of the filter holder. Drill two holes through the short length of brass rod, at right angles to each other; drill two more holes into the ends of the rod, so that they intersect the first two. Tap the end holes for the stove bolts. Slip one rod into each of the untapped holes, and use the bolts for locking the brass block in position. You thus have an arrangement that is simple and at the same time adjustable as to height, distance of the filters from the base, and angles of the filters. Lacquer the wood parts and the iron base.

Just one more item and your filter equipment will be complete. You will, of course, need a source of artificial light that can be focused and projected through the filters to the reflecting mirror of your microscope or on the specimen directly. Many lamps are sold expressly for this purpose, but these are expensive and the simple homemade device shown in the photographs will answer your purpose.

To make such an illuminator, procure a metal-case, focusing-type flash light having a good reflector that will bring the lamp-filament image to a point. Remove the batteries, if any, and cut the center part out of the case, leaving the two threaded ends and an inch or so of intervening metal. This process eliminates the switch also. Solder the two threaded portions together so that you have, in effect, an extremely short flash light case. Obtain a 6 to 8-volt bell-ringing transformer designed for 110-volt house lighting circuits. Run a band of metal around the flash light case and bolt it to one end of a piece of hard composition. Through the other end of the composition drill a hole and slip it over one of the secondary binding posts of the transformer. The transformer thus becomes the base of the lamp.

Use a Mazda No. 40 lamp, the type intended for six-volt radio dial light installations, in the illuminator. This bulb, costing about ten cents, has a rated life of 1,000 hours on normal voltage. The transformer may produce a little more than six volts, which will shorten the life of the lamp a little, but will make up for it by giving a more brilliant light. You can, of course, operate the lamp on a six-volt storage battery instead of a transformer. The lamp holder, that used to be a flash light case, can be tilted up or down, to direct the light through the filters into the microscope mirror or on the microscope stage when opaque objects are being viewed.

NOW that you have found how to make a ten-dollar microscope perform like one costing a small fortune, you are prepared to go visiting among some of the most expert workmen of the world and see, with the aid of your magic lenses, just how they carry on their delicate and deadly work. These workmen are the spiders whose webs you see every place, but whose beauty and wonders of craftsmanship you cannot appreciate without a microscope.

Before you draw any rash conclusions about the desirability

of spiders as material for study and entertainment, consider two things about them: First, the spider does not deserve the bad reputation that most persons are inclined to give it. Perhaps you think of a spider as something horrible, as a creature that will jump out and bite you with poisonous fangs at the first opportunity. The truth is that the spider doubtless is far more afraid of you than you are of it; and that only a few spiders possess a poison that is injurious to man. A spider merely seems horrible because you do not know him better.

SECOND, spiders have one big purpose in life—to capture and devour flies, along with other assorted insects. If you keep this in mind, you can understand much of the work that the spider does, as well as appreciate some of his anatomy. It is to capture flies that a spider erects a web that is a real engineering triumph. It is to kill flies that the spider ejects a poison through two fangs that the low powers of your microscope will reveal. It is to see flies that the spider has, on top of its head, a set of bright eyes. It is to enable the spider to bind a fly hopelessly in the twinkling of an eye, that it has a wonderful silk-making plant.

So it's the old story of the spider and the fly that you are going to investigate. But what a different story it becomes under your lenses!

Before you start peering at spiders, inspect a few webs. If you can find one of those silk creations of an orb-weaving spider, that hang in your garden, you have material for an interesting hour at your microscope. Touch, carefully, one of the silk strands that run out from the center of the web to a point of support. Nothing happens, except that the spider crouching at the center may become excited. Now touch one of the strands that run across the radiating threads. It sticks to your finger.

Push two common pins into a piece of cork or soft wood, about an inch apart, and carefully pick up some of the web threads, so that the silk is stretched between the upright pins. Try to get both the radiating and cross threads. Take this to your microscope, and focus it on one of the cross threads. At a hundred diameters, you will notice that the thread is not smooth as you had believed, but seems to be like a string of beads. Step up the magnification to 300 or more diameters, and you will see that the silken strand really is covered with tiny beads, often arranged with large and small ones alternating. On the heavier radiating threads of the web, you find no beads.

YOU have discovered one of the secrets of the spider web. The droplets or beads on the cross threads are composed of a sticky substance secreted by the spider. Their purpose is to hold any fly that happens to blunder against the web. The spider, then, is the real inventor of fly paper.

Now that you have had a glimpse of the uncanny workmanship of the web-building spider, you are ready to carry your investigations closer to that master spinner. But you need not, as yet, capture a live spider. Look carefully about the webs in your cellar or garden, and you will find, in some of them, what appear at first glance to be dead spiders. These are not dead spiders, but are the cast-off skins of perfectly live and active individuals.

These skins make excellent material for study because, in casting them off, the spider let go with them

many of the intimate details of its external make-up. The skins, for instance, show every detail of the feet with their interesting claws, the "chelicerae" with their poison-ejecting fangs or claws, the remains of the silk spinnerets, and even the hairs that cover the body and legs. The spider has, in shedding its skin, provided you with a better microscope specimen than you could prepare.

In handling this shed skin, you will have to exercise care because it is very light and fragile. A breath will blow it away, and careless handling with tweezers will crush the parts. If you want to preserve portions of the specimen, you can mount them in balsam, in built-up shellac cells. Be careful to eliminate all air bubbles from the hollow parts.

A SPIDER has six pairs of appendages or projections extending from its body. Beginning at the head and working backwards, you find first a pair of chelicerae, jawlike in appearance and in many species made up of two parts. There is a stout-looking, hair-covered base or mandible with a curved, claw-like fang at its end. This claw can be folded down against the base like the blade of a knife.

When a fly blunders into the web or is otherwise caught, the spider sinks its fangs into the victim's body, perhaps also wrapping it in a silken straight-jacket. Poison from glands situated inside the fore part of the spider's body is forced out through tiny ducts in the fangs, killing or stunning the fly. There are a few spiders whose poison is harmful to humans; but the chances are that if you avoid the Black Widow, you never will suffer a spider's bite that is poisonous enough to cause worry.

After the spider has poisoned its victim to insensibility or death, it proceeds to enjoy a feast. But it does not chew the fly and swallow it. Instead, it brings into use the second pair of appendages, called by scientists the "pedipalpi." Their bases serve as jaws for pressing the food to extract the juices, much as you crush a lemon in a squeezer. The juices are taken in through a mouth which is connected to the sucking stomach. After the feast, the spider discards the crushed skeleton of the fly. You will find these remains in almost every web.

So far, you have disposed of two pairs of appendages. The four remaining pairs are the legs which, by their number, distinguish the spider family from that of the six-legged insects. The first pair of spider legs apparently serves much the same purpose as the antennae or feelers of insects.

Examine one of the legs under your microscope. You will find seven joints, with two or three claws at the end of the last segment. When there are three claws, two are arranged to form a pair, and the third is smaller and placed below the others. The large claws usually are equipped with teeth like a comb, and often the small one is toothed. Web-spinning spiders often have a number of accessory claws which are modified hairs that help them cling to the web.

MANY species have, on the tips of their legs, groups of hairs that enable them to cling to smooth surfaces, probably because of a sticky fluid that is secreted. In addition to all this equipment, the spider's leg usually is covered with simple hairs. Some nature students believe that the presence of so many hairs on the legs of web-spinning spiders prevents them from falling, the web strands catching beneath the projecting hairs if the spider's foot slips.

Your investiga-

tions of the silk-manufacturing part of a spider's anatomy will begin with the spinnerets found at the rear of the abdomen, on the underside. You can see vestiges of these on the skin that the spider shed, but you can get a much clearer picture by using a recently killed specimen. Simply capture a web-spinning spider and drop it into a bottle of alcohol for a few minutes.

The spinnerets, usually six in number, are arranged in three pairs. In general, they are covered with hair. They have hundreds of tiny tubes through which the silk-making fluid emerges from the silk glands.

Perhaps you wonder why there are so many silk tubes, and why an apparently single strand of web material really is the fusion of hundreds of tiny threads. The answer is: Speed! When a spider discovers a fly in its web, it rushes out and quickly wraps the victim in silken strands. The silk fluid, emerging through so many openings, hardens instantly upon exposure to air. Were there but one or at most a few openings, the comparatively large strands of silk would require more time to harden, and the spider could not spin its web rapidly enough to be of much help in building an insect trap or in binding its captives.

Now that you have been introduced to this master workman don't you feel a little more kindly towards it? Spider webs may be a nuisance in your parlor, but those in fields and gardens and wherever else they do not interfere with your activities are a real benefit because they kill flies.

It is partly in this way that your microscope earns its keep: It makes you acquainted with the little creatures with which you are forced to live, and helps you distinguish your friends from those that would harm you.

Popular Science Microscope Articles.

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Rainbow Tints GIVE GREATER POWER TO YOUR Microscope

By MORTON C. WALLING

POPULAR SCIENCE MONTHLY
APRIL, 1936

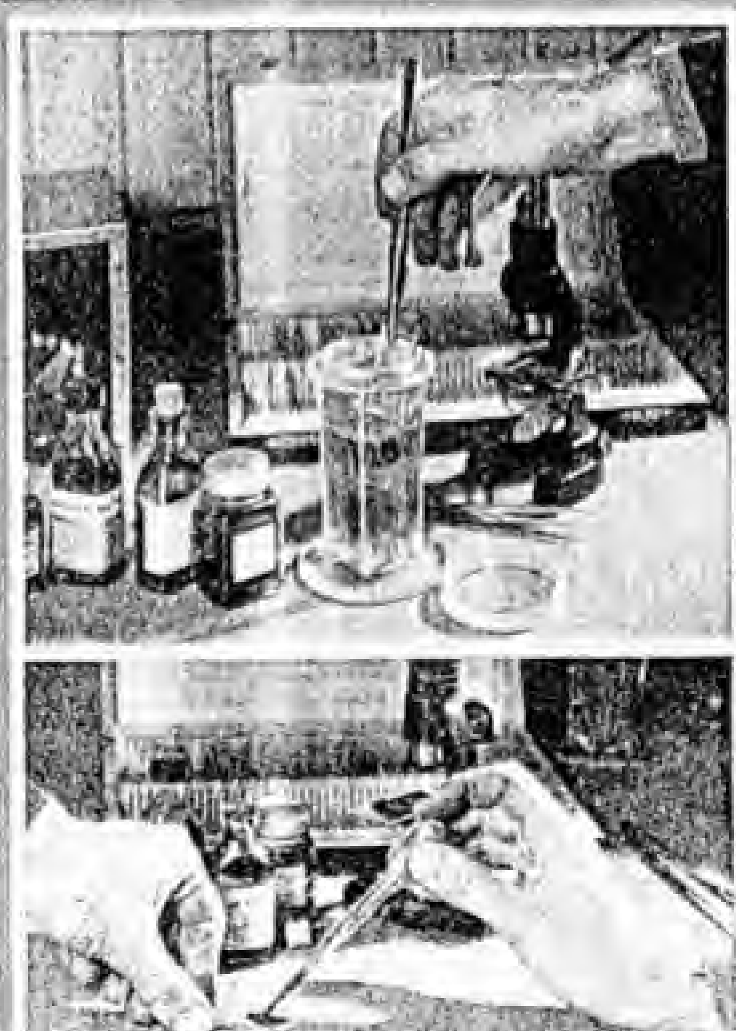
Color Filters and Stains, Readily Made at Home, Enable the Amateur To Obtain Greater Detail and Contrast When Viewing Many Types of Specimens

With the handy light and filter holder above, it is easy to add the use of color filters to your microscope work

THE amateur microscopist pursues his hobby in a world vivid with color. Many of the things he sees through his magic lenses have great beauty because of their effect on the color-sensitive mechanism of the eye. But aside from the purely spectacular effects of color as observed in specimens under the microscope, a knowledge of stains and light filters and color-sensitive photographic materials enables the microscopist to see things he otherwise would overlook, to improve the performance of his lenses, and to make better permanent records of his discoveries.

The microscope owner's first contact with color usually comes when he looks at some convenient natural object such as flower pollen, a piece of a leaf, or a sea shell. Here the color is inherent in the object. But very often a great improvement can be made by adding color where none existed before. That is where solutions of dyes, commonly known as microscopists' stains, become useful.

Dyes may be used to stain thin and very transparent specimens to make them more easily seen. Some materials, such as animal tissues, can be treated with a dye to make certain parts stand out more prominently. Thus the nuclei of cells usually are dyed to make them easy to see. Hæmatoxylin, a bluish-purple dye, is a common nuclear stain. Even when a dye affects all parts of the preparation, it frequently serves to bring out the detail by coloring denser portions more deeply than others and thus creating a contrast.



One way to stain specimens is to apply a few drops of dye with a medicine dropper and then rinse the slide in water or alcohol. Another method (upper) is to immerse the mounted specimen in a jar of stain

Stains are employed in combinations when it is desired to create the greatest possible difference in appearance between parts. For example, when animal tissue is stained with hæmatoxylin to make the cell nuclei more prominent, an additional staining with eosin, another dye that should be in every microscope laboratory, will make the cell bodies more distinct by coloring them red or pink.

Thus the microscopist, with his dyes, alters various materials and makes them more suitable for microscopic examination. The necessary stains are not costly; in fact, some of them can be found in the home medicine cabinet. A few of the more common staining materials are:

Tincture of iodine. Weaken the usual standard solution with five parts of alcohol or water. Try it on the thin membrane peeled from a piece of onion, and note that it stains the cell nuclei brown. Now try it on a piece of potato. The blue color indicates starch grains.

Mercurochrome. It can be used for animal tissues and many other objects, producing a red color.

Hæmatoxylin. This dye usually is employed in a solution that contains several other ingredients and requires considerable time to "ripen." It is best, therefore, to purchase it from a dealer in microscope supplies, or a local drug store that stocks it. Thin sections of animal and plant tissues are stained in a few minutes in hæmatoxylin solution.

Eosin. It can be dissolved in either alcohol or water. For an alcoholic stain, use about one gram of the dye to 300 cubic centimeters of ninety-five-percent alcohol. Perhaps the best all-around staining solution for the amateur is made by dissolving one part by weight of dry eosin in 200 parts of water. Eosin acts very rapidly—in thirty seconds or less with thin tissues.

Methylene blue. This dye is used in an alkaline solution, and can be purchased ready-mixed under the name of Loeffler's methylene blue solution. To mix the stain yourself, make a saturated solution of the dry methylene blue in alcohol. Mix thirty cubic centimeters of this with 100 cubic centimeters of distilled water to which have been added two drops of ten-percent potassium hydroxide solution. Methylene blue is useful for coloring a great variety of

objects. It is a good bacteria stain. To color bacteria in milk or buttermilk, smear a drop of the material on a clean slide and let it dry. Let a drop of alcohol fall on it, and touch a lighted match to the alcohol. This fixes the bacteria—kills them and preserves their form. Now drop some Loeffler's solution on the smear, let it act for a few seconds, and rinse in water. If the stain appears too deep, you can wash some of it out with alcohol. Milk contains bacteria large enough to be seen clearly at 400 or 500-diameters magnification, with a microscope having good lenses.

These are but a few of the many stains the microscopist can use. Some of the staining methods employed for bringing out certain details of animal tissues and the like are time-consuming and involved. If you are interested in them, consult a standard text book on microscopy. Very often, amateur staining requirements can be met with the simplest of coloring materials. The various dyes sold for coloring clothing are worth trying. Even water colors from a child's paint box can be used sometimes.

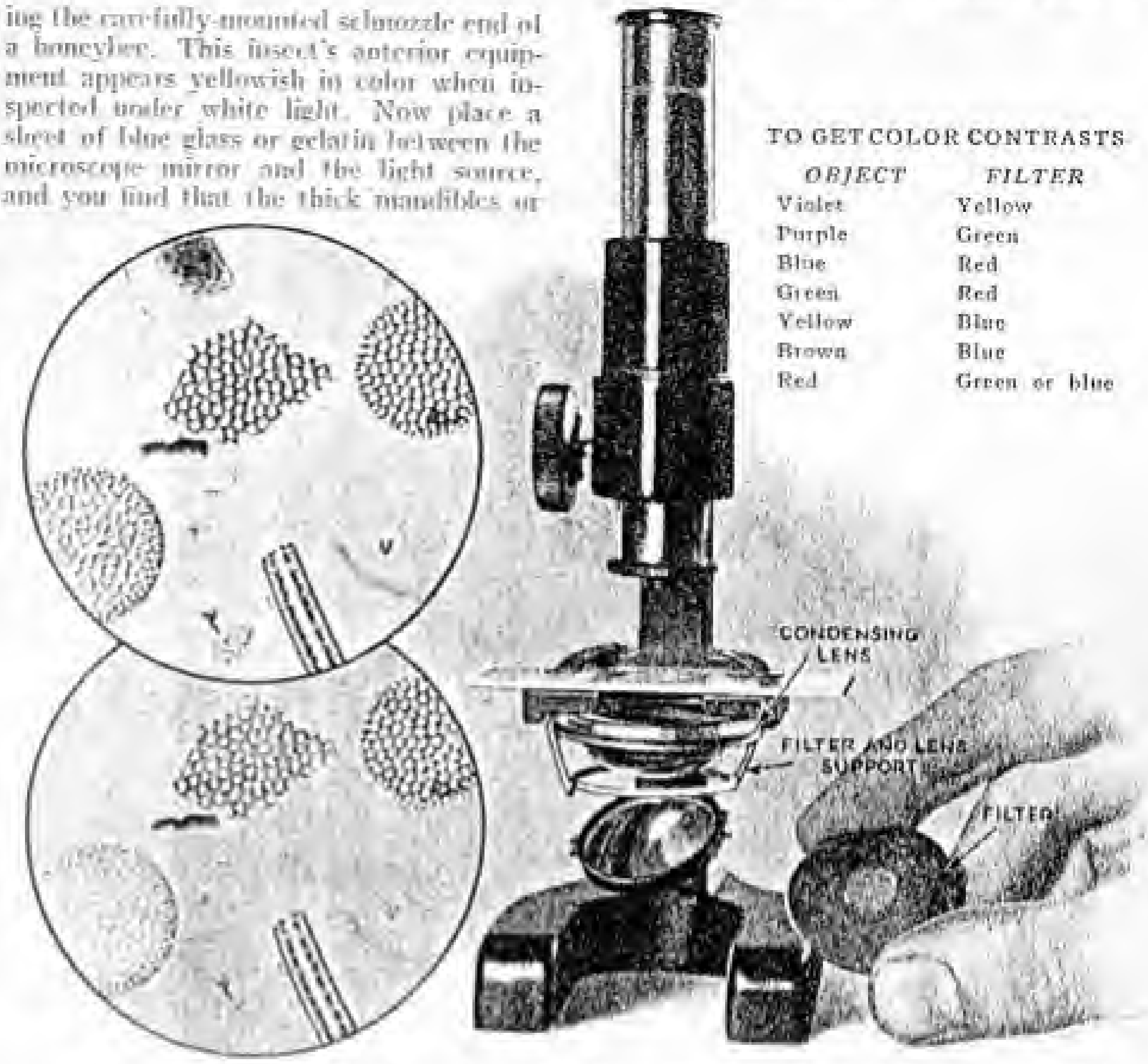
While the microscopist often adds color to the object he wishes to see, he frequently subtracts color from the light with which he illuminates it. Ordinary daylight contains all the colors of the rainbow merged to produce white light. Whenever you remove some of these colors, you leave others that affect your eye.

The microscopist controls the color of the light entering his lenses by the use of filters made of colored glass, gelatin or cellophane, or even bottles containing colored water. And by this simple little trick he can work seeming wonders.

You have, for instance, a slide containing the carefully-mounted schnozzle end of a honeybee. This insect's anterior equipment appears yellowish in color when inspected under white light. Now place a sheet of blue glass or gelatin between the microscope mirror and the light source, and you find that the thick mandibles or

TO GET COLOR CONTRASTS

OBJECT	*FILTER*
Violet	Yellow
Purple	Green
Blue	Red
Green	Red
Yellow	Blue
Brown	Blue
Red	Green or blue



COLOR FILTERS SHARPEN IMAGE. The lower photomicrograph of diatoms was made with white light using a microscope equipped with achromatic lenses. The upper view was obtained with the same equipment and specimens by using green light produced by filters

jaws of the insect become less transparent, while the fuzzy tongue and other delicate parts stand out more prominently.

What happens is this: The blue filter absorbs most of the yellow light that otherwise would have reached the slide. The bee-mouth parts absorb the blue light and, since there is no yellow light for them to transmit, appear black to the eye.

Now, if you had used a red, yellow, or orange filter instead of a blue one, the thicker parts of the specimen would become more transparent, and the delicate hairs and other finer details would fade out a bit.

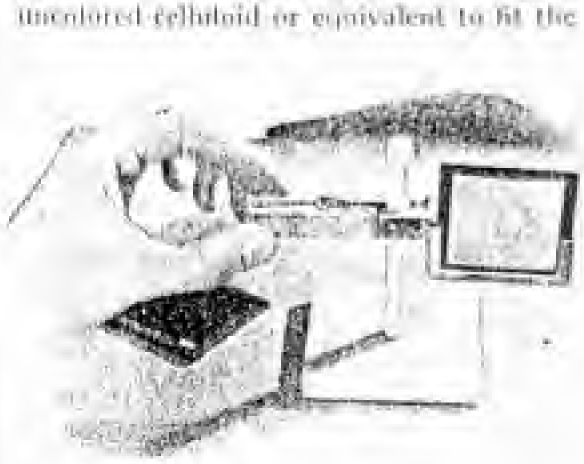
By selecting filters of a color that will absorb the natural color of the object, you can make it appear darker to the eye. This frequently is useful when faintly stained preparations are being viewed. Various colors in the object require, of course, filters of different colors, when it is desired to increase contrast.

By selecting the proper filter, you can emphasize certain details of a specimen containing several colors. Thus, when examining a section of tissue having cells with blue nuclei and red bodies, you can make the nucleus of each cell appear darker and the rest of the tissue lighter by using a red filter.

Filters light-blue in color are used by many microscopists for transforming incandescent electric light into light that is very close to daylight in quality. This makes it possible to judge colors of the

Color-Filter Holder Is Easy To Make

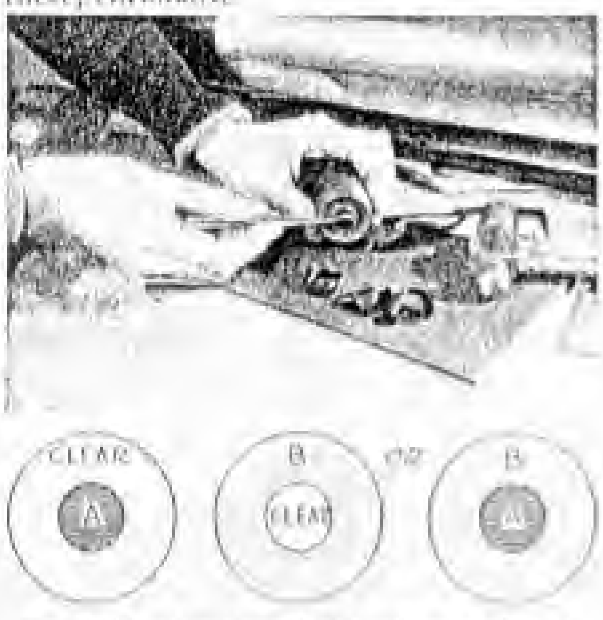
IT IS a simple matter to make an adjustable filter holder that can be set on the table or attached to the lamp used as a light source. A convenient size is two by two inches. Cut two pieces of glass to this size. Wash and dry thoroughly. Then sandwich a sheet of filter material between the glass pieces and bind the edges with lantern-slide or adhesive tape. If the microscope has a substage filter holder, a suitable filter can be made by cutting a disk of uncolored celluloid or equivalent to fit the holder. Now cut a disk of the same size from the filter material. Put the two disks together and bind with Scotch tape.



Binding a filter holder with transparent tape. On the table is one bound with lantern-slide tape. The adjustable holder (left) consists of a snap clothespin fastened to a U-shaped copper channel, a wooden dowel pin, and a base

specimens more correctly, and also tends to lessen eye fatigue. Glass flasks or flat-walled bottles containing solutions of copper sulphate or other coloring materials that give a blue tint to the water have been used widely. However, the more convenient glass or gelatin sheet filter is replacing the clumsy bottle in many laboratories. Some microscopists prefer, for long study at the microscope, a light green filter to lessen eye fatigue.

Another important function of color filters is to improve the quality of microscope lenses. When an optician makes a lens, he eliminates, as far as possible, inherent defects or aberrations. Two of these, chromatic



Two knife-edge rings fashioned on a piece of shafting make a tool for cutting out perforated filter disks and center inserts, as shown

and spherical aberration, are caused by the action of different wave lengths (different colors) of light passing through the lens.

The best lenses, which are corrected for several colors, are priced so high as to be out of reach of the average amateur. While the better makes of low-priced instruments have lenses that, for the money, are excellent, many of the cheaper ones seem incapable of focusing any color at all. Much of the trouble comes from the fact that the lens system brings each color of light to focus on a different plane, the combined result being a blurred visual image.

Fortunately, even the poorest lens usually can be improved by screening out some of the colors, and examining the object by the wave lengths of light that can be brought to a focus at one point. This is easily accomplished by use of color filters; although, with stained or otherwise colored specimens, the use of a filter for improving the lens performance may destroy the advantages of color in the specimen.

Perhaps the best color to use for making cheap lenses behave like costlier ones is green or greenish yellow. Sometimes a blue-green color will prove best. The best method is to try various colors until the most satisfactory one is found. The main idea is to use a filter that confines the light beam to a narrow band of the visible spectrum. Sometimes a combination of two filters will do the trick, such as the Wratten G and H filters, which transmit a pure green. Unless the filter is very light in color, it is advisable to use more light, to overcome the loss of intensity resulting from absorption of some of the colors.

FOR observing very fine details, the use of a blue-green filter is desirable because this increases the resolving power of the microscope. Since resolving power depends on the wave length of the light used, being greater with shorter wave lengths, the elimination of the long-wave red light is desirable.

Anything that is transparent and colored can be tried as a filter. The best way of judging its success is simply to see how well it works. If you live in a city where there is a theater-supply house, you may be able to obtain little sample filter books. These contain many small sheets of transparent gelatin of various colors. You can use these sheets as test filters, although they may be a little small for some purposes. Larger sheets can be purchased for a few cents each. One such piece will make enough filters for a dozen microscopists, with enough left over for a set of color-differentiation filters, which will be described.

You can purchase colored glass in sheet form and cut to whatever size you want for use as filter material. The "five-and-ten" may yield useful filters in the form of colored celluloid or cellulose film.

If you want something scientifically correct —something concerning which accurate information is available as to wave length of the light transmitted and absorbed—you can get one or more Wratten filters. These are obtainable in the form of gelatin sheets costing a few cents per square inch, or as gelatin cemented between optically flat glass plates. Glass-mounted filters are made in sizes that will slip into the filter ring mounted below the condenser of high-grade microscopes. The filter best adapted for any given purpose can be determined by consulting the manufacturer's charts.

If you employ colored gelatin for microscope filters, it will be necessary to mount the sheets between glass, to preserve them. The gelatin sold for use over theatrical and store-window lights is fairly durable, but all that the writer has seen is affected by water. The Wratten filters in sheet form are damaged by touching with the fingers.

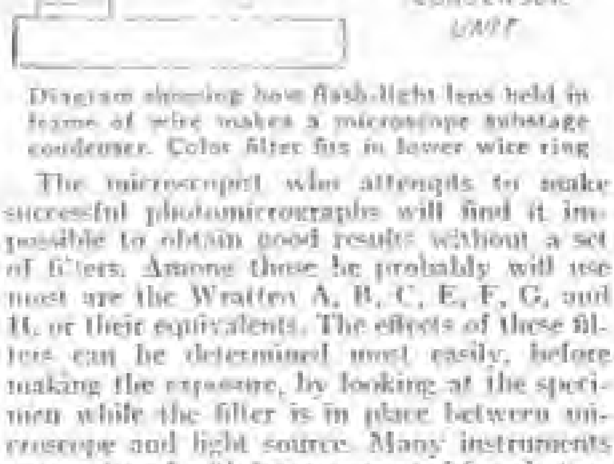


Diagram showing how flash-light lens held in frame of wire makes a microscope substage condenser. Color filter fits in lower wire ring

The microscopist who attempts to make successful photomicrographs will find it impossible to obtain good results without a set of filters. Among those he probably will use most are the Wratten A, B, C, E, F, G, and H, or their equivalents. The effects of these filters can be determined most easily, before making the exposure, by looking at the specimen while the filter is in place between microscope and light source. Many instruments not equipped with lenses corrected for photography perform best with green light as produced by using the G and H filters in combination, or with the green, B filter alone. Orthochromatic plates or films can be used for making photomicrographs by green, yellow, blue, and other light that contains no red. When red rays are involved, panchromatic negative materials are necessary; and these can be used also for all other colors.

If you have a microscope equipped with a substage condenser and a filter ring, you can experiment with differential-color illumination —and feast your eyes on some of the most beautiful sights to be found in the field of microscopy. If your microscope is not equipped with a substage condenser, you can rig up one, using a plano-convex or bullseye flash-light lens in the manner shown in the illustrations.

The substage condenser directs a cone-shaped beam of light upward towards the slide, bringing it to a focus in the plane of the object. Now, if you arrange things so that the center of the beam is of one color and the outer portion of another; and if the condenser is focused properly, a striking effect is seen. The object appears colored, against a background of another color. The color of the center of the beam determines the background color, and of the outer ring, the color of the object.

To make a set of color disks and rings similar to those employed in the Rheinberg system of differential-color illumination, you need only cut colored rings and mount them on suitable supports as described, or cement them between very thin sheets of glass or other transparent material; and colored disks or central stops, and mount them in the same way. The hole in the ring is the same diameter as the central stop. For a standard American microscope, make the ring thirty-three millimeters outside diameter, with a sixteen-millimeter hole; and the colored central disk sixteen millimeters. For homemade, bullseye condenser systems, different dimensions may be necessary, these being found by trial. Usually a smaller center disk is necessary.

Suitable colors for the rings include red, blue, yellow, orange, and green. For the central disks, red, blue, green, purple, and black.

THESE disks and rings are inserted into the microscope filter ring in pairs, to give various combinations of colors. Thus, with a red ring and a blue disk, the object will appear red against a blue background. Remove the disk but leave the red ring in place, and you will see a red object against a white background. Insert the black disk, and the object will be red against a black field. If you close down the iris diaphragm below the condenser, the object is seen in a color determined by the center disk.

In viewing diatoms, radiolarians, insect eggs, plant pollen, and a host of other objects, this system increases the beauty and helps bring out detail. In laboratories, differential illumination is used extensively in the examination of uncolored woven materials. The woof can be rendered in one color and the warp in another.

To accomplish this, a sector stop is used. This consists of a two-color ring stop with the colors arranged alternately in quarter (ninety-degree) segments. In making an observation, the disk is rotated until one color brings out the detail in one direction and the other emphasizes that in the transverse direction. By using a ring stop half (180 degrees) red and half blue, one side of the object will be illuminated with the red and the other with the blue light.

In cutting the disks and rings from colored gelatin, it is advisable to use a method that will produce clean, even edges. Careful work with fine shears will do the trick. One microscope enthusiast uses a set of leather punches, which he obtained from a hardware dealer. These punches are essentially ring-shaped hollow chisels which are struck with a hammer.

One of them cuts the outer circumference of the ring, and the other punches out the center and at the same time forms a center disk. A piece of dense composition building board or a sheet of zinc can be used as a surface on which to cut.

IF YOU have a lathe, you can make a tool that will cut both ring and disk with one blow. On the end of a piece of shafting of suitable diameter, turn two knife-edged rings, of the correct diameters, and projecting at least one eighth of an inch. If you have many rings to make, it will pay you to have the cutting edges hardened. The overall length of the piece of shafting should be four or five inches. To cut unperforated disks for mounting the color rings and small disks, lay the material to be cut over a hole made in a piece of soft wood, this hole being slightly less in diameter than the outer cutting edge. The center cutter, having nothing against which to act, will not affect the material.

Ready-made Rheinberg color rings and disks, of colors selected with scientific accuracy, can be purchased from the same source as Wratten filters.

POPULAR SCIENCE MONTHLY JULY, 1938

Colored Glasses Help Your Microscope

EASILY MADE LIGHT FILTERS CAN IMPROVE THE PERFORMANCE OF YOUR MAGIC LENSES AND REVEAL UNSUSPECTED WONDERS TO YOU

by MORTON C. WALLING

One of nature's engineering marvels, a chicken feather, being prepared for examination with the aid of light filters

AMONG the important microscope accessories, few that are readily available to the amateur will give him more return for his money or effort than a set of light filters. Easily made from inexpensive materials, or purchasable for a moderate sum, filters add fascinating color contrasts to the objects you place on your slides. They bring unexpected powers to even the weakest lenses and, if your hobby is photomicrography, they make possible pictures that you never thought you could catch on a photographic film.

Several of the illustrations on these pages show what filters can do to bring out details of the fascinating structure of feathers (P.S.M., June '38, p. 40) viewed and photographed under a microscope. Filters of different colors and degrees of translucence have varying effects on what your microscope shows you, and permit you to "hold back" certain things appearing on your slides, while emphasizing the clarity of other things.

A filter of the kind the microscopist uses is simply a translucent, colored medium whose function is to absorb some wave lengths (colors) of light while it permits others to pass. Filters are used, in visual observation and in photomicrography, for two main purposes. They make the microscope lenses perform better, and they control contrast between the object and its background or between different parts of the object.

Filters can help overcome some of the shortcomings of cheap microscope lenses, and can improve the performance of even the best lenses of research microscopes. If the visible spectrum consisted of but one color of light, that is, one narrow band of wave lengths, the lens maker's job would be relatively simple. But it happens that the visible spectrum contains a number of distinct colors, ranging from violet to red. In passing through a given lens, each color is bent or refracted an amount different from the other colors. The result is that all the colors are not brought to a focus at the same distance from the lens—violet and blue being refracted the most and therefore forming an image closer to the lens than red, which is refracted the least.

In the cheapest microscope lenses, the makers usually try to bring the wave lengths we see most easily (yellow-green) to sharpest focus, and let it go at that. In other words, they correct the chromatic and spherical aberrations for but one color, if at all. (Chromatic aberration refers to the inability of a lens to bring all colors to a focus at the same distance; spherical aberration, to the inability to focus rays passing through the edge of a lens on the same plane as those passing through the center.) Professional-type microscopes are fitted with lenses having higher degrees of correction, which is one reason why they cost so much. For ordinary work, achromatic objectives having the chromatic aberration corrected for two colors, and spherical for one color, are employed. For more precise work, especially photomicrography with white light, apochromatic lenses are used. In these, the chromatic aberration is corrected for three colors and the spherical for two.

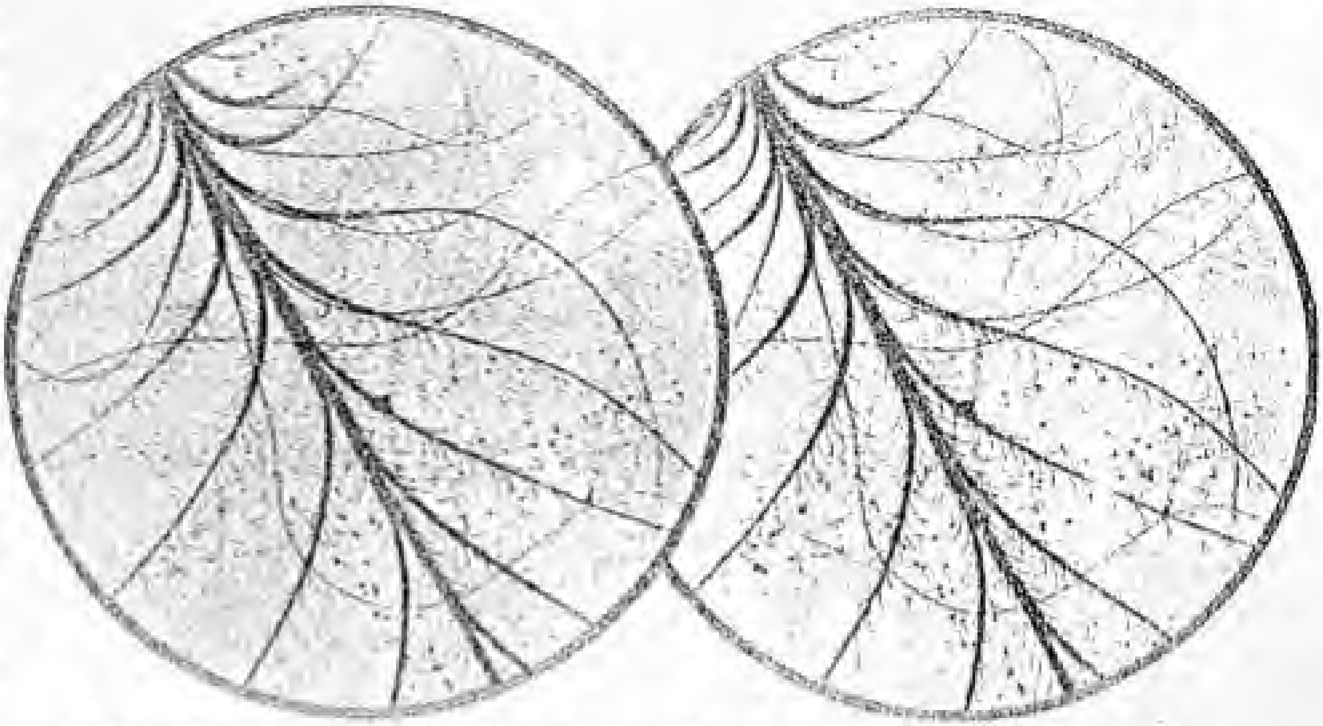
Obviously, if a microscope lens cannot bring all colors to a focus at one point, the image will not be of maximum sharpness. And, just as obviously, if you can eliminate some of the colors and examine the object by one relatively narrow band of wave lengths, the image will be sharper, because that narrow band or color can be focused with reasonable sharpness at one point. And that is where filters enter the picture.

A filter appears colored to the eye because it transmits some wave lengths

and absorbs others. If you select a filter that transmits the color that the microscope lenses focus best because spherical aberration has been corrected for that wave band, and absorbs the colors that come to a focus either nearer the lens or farther away than the transmitted color, the image will look sharper. The best way to determine just what color filter to use is to try different ones and observe which makes the image the most distinct. Usually a green filter, or a green and yellow one together, will work best. For instance, achromatic objectives used in conjunction with a Huyghen's eyepiece (which is the type eyepiece normally employed) produce maximum sharpness with Wratten "B" and "G" filters together.

Because a filter absorbs some of the light, it reduces the intensity of the light passing through it. Therefore, in order to obtain sufficient illumination through the eyepiece, you probably will have to increase the intensity of the light source used for observation. If you use electric light, a lamp of greater wattage will solve the problem.

The second great use of filters in microscopy, the control of color contrast, depends also on the light-absorbing and transmitting properties of translucent colored material, and on the observing of objects that contain color. If you like rules, here is one that you can remember in connection with contrast control: Contrast is increased when the filter *absorbs* the light that the object transmits. And it goes without saying that, when the filter *transmits* the light that the object transmits, contrast is reduced. Usually there is a happy medium between these extremes that produces best results.



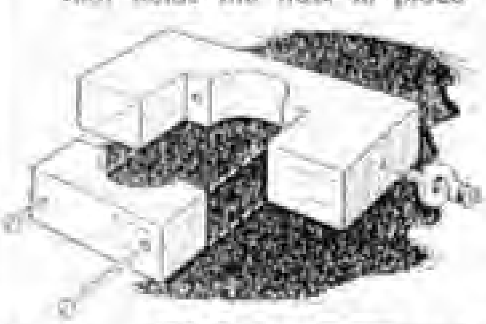
Bird feather viewed through different filters. Note the improved contrast at the right

The easiest way of determining just what filter to use to make a certain colored object, such as an insect leg or a piece of stained tissue, appear at its best, is simply to look at it by light of different colors. Here is a table that will help you select filters when you want to produce maximum contrasts:

COLOR OF OBJECT	FILTER TO USE
Violet	Yellow
Purple or Red	Green
Blue or Green	Red
Yellow or Brown	Blue

As an example, the horny legs and various other parts of insects are yellowish in color. If you employ a violet filter with them, maximum contrast will be produced. That is, the leg will appear black against a blue background. Usually, however, because of the thickness of the specimen, such contrast increase will blot out details. So it is desirable in such cases to reduce contrast rather than increase it. Remembering that maximum detail is seen when the object is examined by light of a color that it transmits, you find that a yellow or a red filter produces best results.

A spherical flask filled with colored water acts as a filter and also as a condensing lens when used as at the left. The drawing below shows the yoke that holds the flask in place



At the right, differential-color disks are being prepared by taping centers of one color over rings of another color. Rings are cut from gelatin with the punch illustrated

IN GENERAL, the effects obtained in making photomicrographs with panchromatic (all-color-sensitive) plates or films used in conjunction with filters are practically the same as the visual effects.

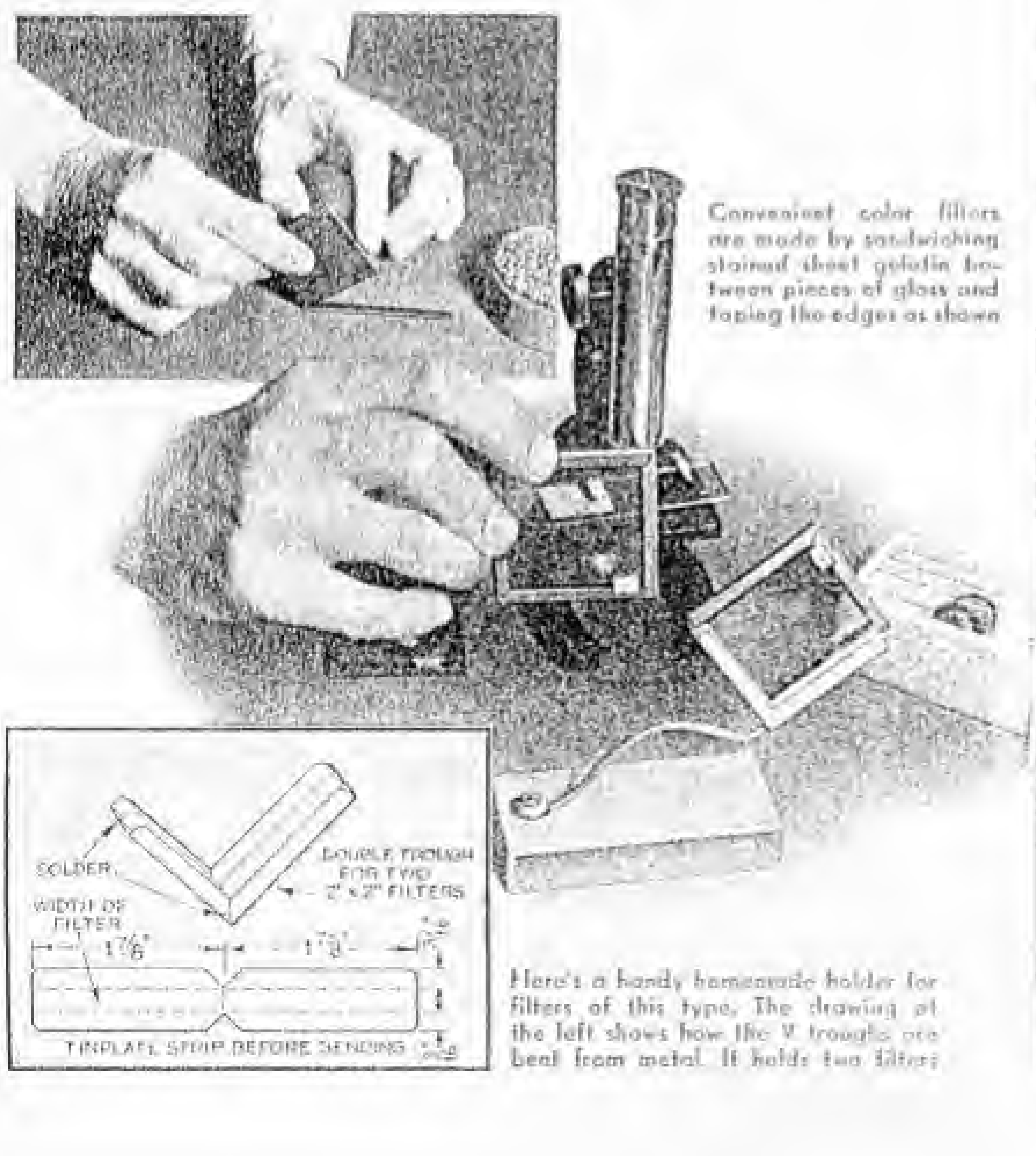
Filters employed in microscopy are almost invariably placed between the light source and the microscope. Professional-type microscopes have slots below the substage condenser and diaphragm to receive disk-shaped filters, 33 mm. in diameter.

There are various kinds of filters that the amateur microscopist can use to improve the performance of his lenses. These include colored glass, colored gelatin of the kind used in lighting window displays, cellulose acetate film, colored liquids, and colored gelatin specially designed for filter work. In fact, almost any colored material that is transparent enough to transmit sufficient light can be used.

IN LARGE laboratories, scientifically made filters are invariably used for both visual work and photomicrography. These provide accurate control of wave length of light transmitted and absorbed. In the United States, probably the filters most commonly employed are those known as the Wratten "M" series. Fortunately, they are not beyond the reach of the amateur, for they can be purchased in the form of stained-gelatin sheets for something like ten cents a square inch. A convenient size is 2 by 2 in. The colors are designated by numbers. A complete set of visual filters would include the following: No. 78, blue, for general use to convert incandescent-lamp light into daylight-quality illumination, which reduces eye strain; No. 38A, blue, to increase contrast of faintly colored yellow objects; No. 45A, blue-green, to enable maximum detail to be seen, as in study of diatoms; No. 66, light green, to increase contrast of red and pink objects; No. 58, green, to increase contrast of very light pink and red objects; No. 15, yellow, and No. 22, orange, to increase contrast of blue objects and improve detail of insect preparations; No. 25, red, to increase contrast of blue objects such as those stained with methylene blue; No. 96, a neutral-density filter for reducing brightness of light without changing color, transmitting about ten percent of the light striking it.

IF YOU intend to use filters in the form of thin sheets of gelatin, cellulose film, or the like, mount them between glass for protection. It is not necessary to use optically perfect glass, because the filter is placed between the light source and the microscope, and does not interfere with the microscope's optical system. Clear glass obtained by washing the emulsion from photographic plates or lantern slides is excellent. At photographic stores, you can purchase 2 by 2-in. squares of thin, flawless glass originally intended for use as cover glasses for photographic transparencies to be projected on a screen. Handle filter gelatin with tweezers, and do not touch it with your fingers, or you will leave smudge marks. Place the gelatin sheet between two pieces of clean glass, and bind the edges with lantern-slide tape, either the gummed-paper type or that made by coating cellulose film with rubber cement. Perhaps some of the metal frames recently introduced for holding small photographic transparencies between the glass squares can be used instead of tape.

Liquid filters consist of colored solutions in water, held in bottles having flat, parallel sides, or in spherical flasks which act also as condensing lenses to concentrate light on the microscope mir-



Convenient color filters are made by sandwiching stained sheet gelatin between pieces of glass and taping the edges as shown

Here's a handy homemade holder for filters of this type. The drawing at the left shows how the V troughs are bent from metal. It holds two filters

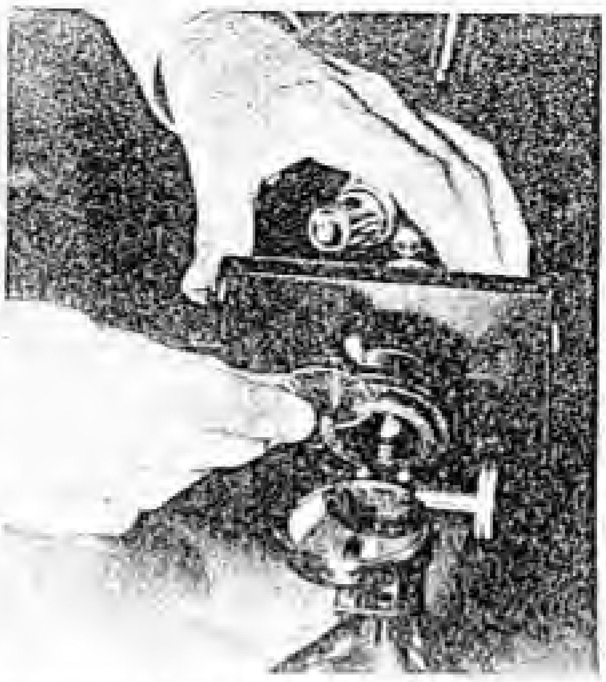
Handy Eye Shade Prevents Confusion of Images

IF YOU are troubled by confusion of images when you look through your microscope with both eyes open, this eye shade will help you. It is made from an old eyeglass frame with a dark frosted glass fitted in one lens rim. The other rim is reduced in size so that it will fit snugly around the ocular holder.

ror or the object. You can arrange a simple holder for such a flask. The main thing is to elevate the flask above the table sufficiently to align it with the microscope mirror and light source.

A COMMON use for a liquid filter such as a flask of colored water is to convert artificial light into daylight-quality illumination and thus reduce eye strain. Solutions of copper salts, which are blue, are usually employed for this. Other liquid filters include: potassium bichromate, saturated, to produce yellow; saturated copper sulphate one part, saturated potassium bichromate three parts, and a few drops of sulphuric acid, green; aniline red or neutral red, one part to about 1,000 parts and diluted as required for thick vessels; chrysoidine, same dilution, producing orange filter.

Strikingly beautiful effects can be obtained by employing differential color illumination. A microscope having a substage condenser is essential. If your instrument is not so equipped, try inserting a short-focus plano-convex



Professional type microscope with substage receptacle provided for filters and color rings

lens, such as those sometimes employed on the end of cheap flash lights, beneath the stage, flat side up.

TO OBTAIN differential color illumination, insert beneath the condenser a ring of colored gelatin having in its center a circular hole whose diameter is about one half the total diameter of the ring. The ring, say, is red in color. Now, with the condenser focused on the object and the iris diaphragm wide open, you will see a red-lighted object against a white background (assuming that the source of light is white). Next, insert a small disk of different-colored material to cover the center hole in the red ring completely, and the color of the background changes to that of the smaller disk. Remove the ring, and you see a white object against a background the color of the small disk. Contrasting colors such as blue and yellow are generally best. Magnification should not be too great, a 16-mm. objective being about the most powerful usually employed. If you cut your own differential rings and disks from colored celluloid or other material, make the rings about 32 mm. outside diameter, and the center hole 16 mm.

Preserving *and* Filing Microscope Specimens

Manner of Making Permanent Record of the Wonders Seen in Your Invisible World Is Described in This Article

By BORDEN HALL

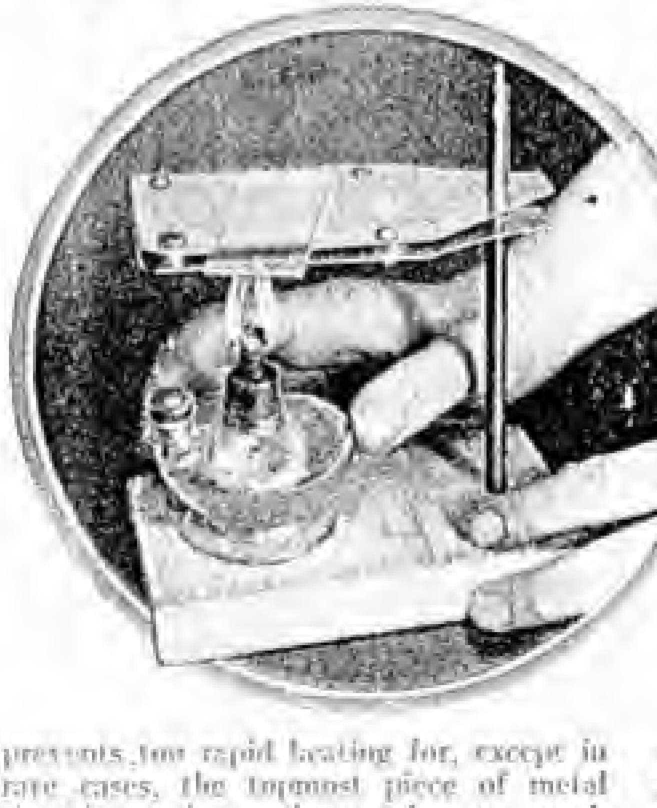
POPULAR SCIENCE MONTHLY MAY, 1933

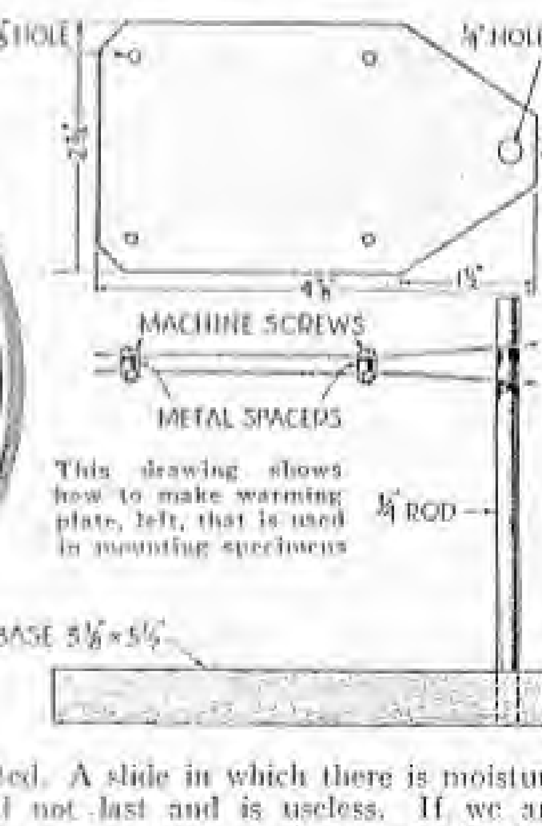
IN OUR fascinating journeys into wonderland, time and time again, we come upon views so striking that we leave them with great reluctance. It is too bad that we should spend half an hour, say, in the preparation of a specimen only to take one look at it and then discard it when a little more time spent with it would make it ours for years to come.

I believe that many of my readers will like to build for themselves a wonder album, a collection of microscopic views and specimens that can be preserved permanently. This is not only a most interesting indoor sport but it makes our work with the microscope useful and instructive. Also, it permits our family and friends to see what we have seen and to marvel with us.

In an earlier installment, you were told how to make a little device to be used in placing circles of Canada balsam upon slip glasses—the little three by one inch windows upon which we have been placing our specimens for examination and which may be bought cheaply at any biological supply house. This device will be needed along with the scalpel, the needles, cover glasses, and a small camel's hair brush of good quality.

Also, we shall need a little alcohol burner and a drying plate such as is illustrated here. This is easy to make. The double bottom is my own idea. It

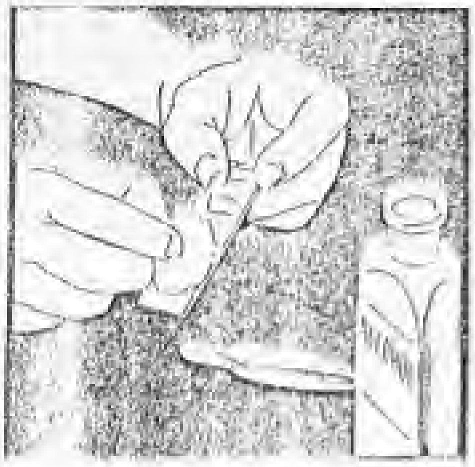




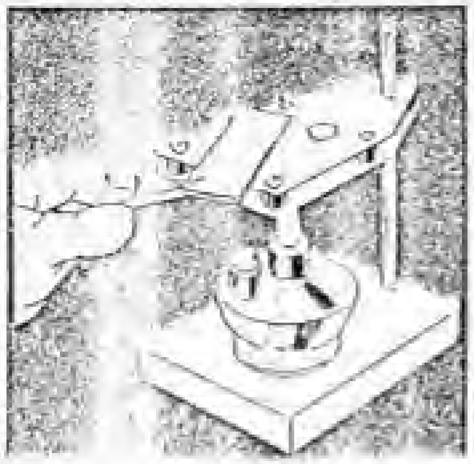
This drawing shows how to make warming plate, left, that is used in mounting specimens

prevents too rapid heating for, except in rare cases, the topmost piece of metal should not be made too hot to touch with the finger. We shall also want some black asphaltum varnish and some white or clear shellac. With this modest outfit, the beginner may do creditable work in the preservation of specimens.

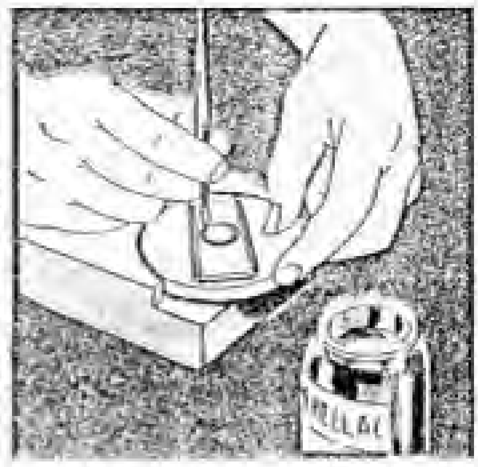
A word of caution: Don't hurry. Keep in mind that you are mounting the specimens to last, and it is necessary to be careful. Above all, remember that moisture and air bubbles must be eliminated. A slide in which there is moisture will not last and is useless. If we are going to prepare specimens at all, they are worth preparing well and we should not forget that we are learning to do a work that today has a great deal of industrial value. Perhaps if we become proficient in mounting specimens we may be able to continue the work with some great corporation that is constantly trying to improve its product. A great flour mill in Minneapolis, Minn., for example, proudly exhibits more than 30,000



1 In mounting a specimen for your microscope, the first step is the cleaning of the glass slide with a cloth soaked in alcohol

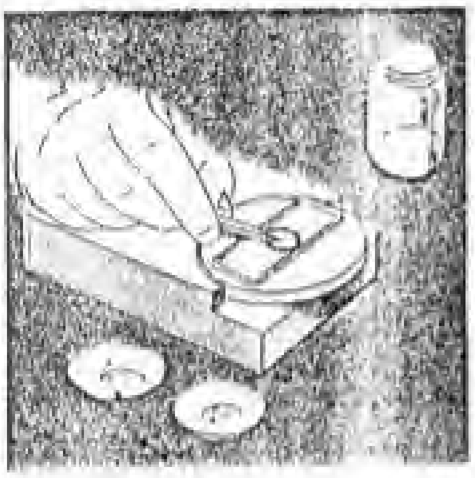


2 Using the forceps, the slide is then laid on the double-bottomed shelf above the alcohol burner and left until it is dry



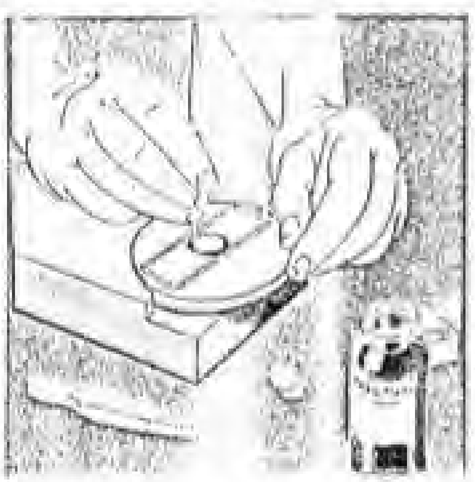
3 Then the slide is placed on the turntable and a brush dipped in Canada balsam or shellac is used to build a tiny circular cell

With your glass slides properly mounted and filed, your specimens are always readily accessible for study or exhibition to your visiting friends



4 When the cell is the right size, the specimen, which has been dried over the burner, is carefully laid in the center of the cell

5 With the specimen in place, a cleaned and dried cover glass is placed, with the forceps, on top of the balsam wall



6 The turntable is then given a spin and a brush that has been dipped in asphaltum is held so it seals edge of cover glass

7 The last step is pasting on the slide a slip of paper upon which you have written the date of mounting and specimen's name

microscopic slides; the result of an investigation that has extended over a period of years and has lowered the production costs and increased the nutritive value of its products.

In a dozen research laboratories today, milk is exposed to powerful ultra-violet light. Then microscopic experts count the dead bodies of the tubercular bacilli to determine the killing power of the rays. Today, the microscope is an indispensable aid to industry.

Our job at present, however, is to prepare a specimen and for our first effort we select what is known as a dry specimen. If we were going to mount the body of a dog flea, we should be dealing with a wet specimen and an entirely different technique would be necessary. To start with, we use the wing of a fly.

The slide and cover glass are carefully cleaned by sponging them off with a piece of soft cloth, free from lint, soaked in alcohol. The slide and glass are then placed on the little warming pan and left there for half an hour. Next the slide is lifted off and placed on the turntable so that the center of the slide is over the shaft of the table. This automatically centers the mounting of the specimen. Under no circumstances should the center portion of the slide be touched with the fingers or any other object after it has been cleaned and dried.

The little camel's hair brush is dipped into the Canada balsam, which has been dissolved in chloroform, unless you secured your supply from a biological supply house, in which case it was already dissolved. With one hand, the brush is held over the slide at the position near which we wish to mount the specimen. The other hand is used to turn the table. The tip of the brush is brought in contact with the moving table at a point far enough from the center to describe a circle a little larger than the cover glass. These cover glasses are usually ⅝th of an inch in diameter, although different sizes may be obtained.

In this way we make what is known as a cell. The tiny circle of balsam builds up a low wall that will support the cover glass and enclose our specimen. The height of the wall depends upon the amount of balsam we deposited with the brush. If the specimen is thick, we shall have to build our wall higher by letting the first ring of balsam dry and then placing another ring on top of it. In this way, we build up a series of rings until the proper height is reached. That is, until the wall is so high that when the cover glass is put on it will not crush the specimen.

Before a second layer of balsam is added, the first layer should be thoroughly dried by placing the glass slide in a

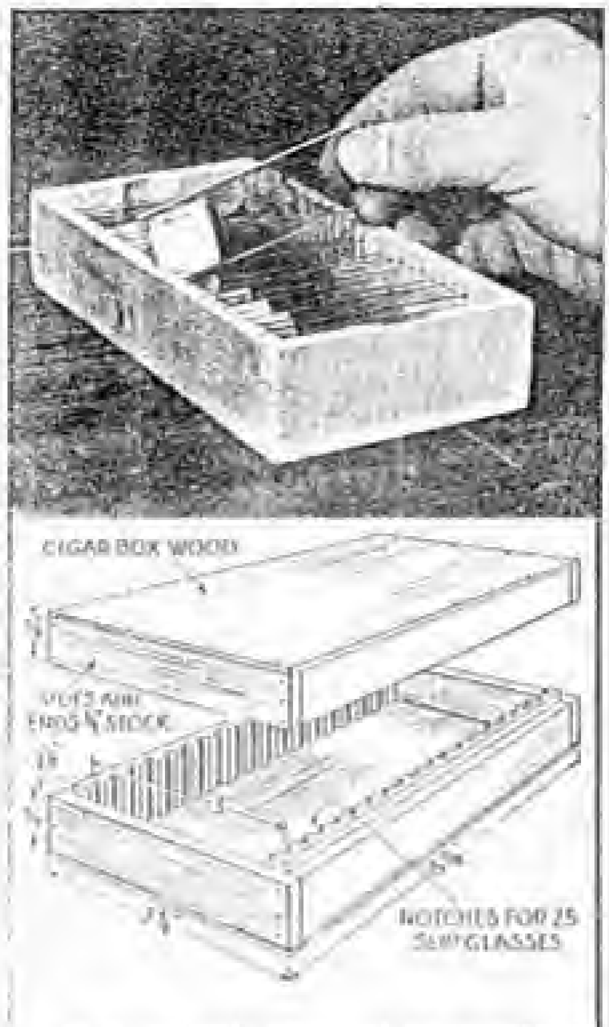
little metal box, free from dust, and then putting it over our little heating pan. We must not forget that we are dealing with objects for the microscope and that if we permit a speck of dust to get into the cell, the microscope will make it look as large as the moon. Then, too, such specks are always the sign of the poor workman.

The specimen must be free from moisture. To insure this, we leave it for a few minutes over our little alcohol heater, protecting it from direct heat by placing it upon a clean slip of glass. While this is drying the inside of the cell is covered with a thin layer of balsam which is permitted to become just tacky. Quickly the fly's wing is lifted with the forceps and placed in the center of the cell. The cover glass is picked up and placed over the wing on top of the wall of balsam and the slip glass is replaced on the turntable. A second brush is then dipped in the black asphaltum varnish and the table is spun while the loaded brush is held so that it overlaps the edges of the cover glass and seals the specimen in. Several turns may be necessary to deposit the right amount of varnish but once done and dried, we have our fly's wing locked in so it will keep for years.

This may sound like a lot of work but I have been careful to outline the process in detail. Actually doing it is much more interesting than the description. When the fingers become trained and you have developed a certain amount of skill, you can mount several specimens at a time, so arranging your work that one thing may be sealed while another is drying.

One big mistake the beginner may make is that of using bits of a specimen that are too large. This is the result of our inexperience as we are untrained for work in a world where tiny things are so large. A friend of mine once placed a piece of fungus, the size of a ten cent piece, under a slide when he should have used a bit the size of a pinhead.

Our next job is to mount an opaque specimen, that is, one that must be studied with reflected light. For instance, if we want to mount the inside of a beetle's wing, which is opaque, we cannot proceed exactly as we did in preparing the fly's wing. The cell, however, is built up in the same manner as before. But after the last application of balsam has dried, a small brushful of black asphaltum is placed inside the wall of balsam. While the asphaltum is still tacky, the specimen, after having been carefully dried, or dehydrated, by the application of slow heat, is lifted with the forceps and put in place. The rest of the procedure is the same as that described for the first mounting.



BOXES FOR YOUR SPECIMENS

You can make your own boxes for glass slides by following directions given in this drawing

Also, it may happen that we want to peer into the inside of specimens and learn the structure of their internal parts. This curiosity is especially keen in regard to the stems of plants and flowers. Cross sections will reveal their wonderful and intricate layers of cells and delicate connecting tissues.

It is obvious that very thin slices of the stems must be cut off in the preparation of such specimens. Indeed, they must be so thin that light will pass through them. To cut slices as thin as this is no small task although from stems that are not easily crushed, slices may be cut with an ordinary safety razor blade. The cutting is done under a reading or magnifying glass and the slices are made as thin as is humanly possible.

IN A more professional method of cutting the slices, an instrument known as a microtome is used. In our next article we shall not only learn to use such an instrument but we shall also be told how one may be made at home with a few simple tools and materials.

The beginner should not become too ambitious in his efforts to mount specimens. If, for instance, he attempts the mounting of any live specimen containing viscera, he is sure to make a botch of it. Our next article will deal with this difficult subject and will tell you exactly how such specimens are mounted so you can make them for yourself.

In cataloging and filing our microscopic album, we shall need a few more simple accessories. Cataloging really should be done as it gives a nice professional touch and makes your collection ready for instant use.

A sticker, bearing the name of the specimen and the filing date, is pasted on each completed slide. Such stickers may be bought at any stationery store. On the end of the box in which the slides are filed is pasted a slip of paper on which is written the names of the slides it contains. Each box is numbered and reserved for a distinct subject.

While such filing boxes may be had at a trifling cost, it is fun to make them. If a dozen or more are made at a time, they will cost you very little in labor or cash.

Soft pine is used for the body of the boxes. The little comb-shaped pieces between which the slides are slipped may be cut by mounting together two circular saws of the same diameter and arranging the saw table so that a cut halfway through the stock will be made. In this way, these pieces may be run through with lightning speed. They are fastened to the sides of the box with carpenter's glue.

IF A dozen boxes are made at once twenty-four ends and slide pieces are put through at a time. As plywood is a little thick for the tops and bottoms of these boxes, a better material to use is cigar box wood.

After each box is finished, by nailing it together with small brads, a long strip of paper, numbered from one to twenty-five, is glued to the bottom in such a way that slide number twenty will be directly above the number twenty on the paper. This makes it easy to find any desired slide.

Slicing Specimens for Your MICROSCOPE

Thin Sections Are Easily Produced with the Help of a Homemade Microtome, or Mechanical Holding Device, the Construction of Which is Described

By MORTON C. WALLING

POPULAR SCIENCE MONTHLY *MAY, 1938*

SINCE the compound microscope is primarily an instrument for looking *through* things at high magnification, the object on the glass slide must be, in most cases, thin enough to transmit light. Many objects, such as insect wings and the stripped-off epidermis of leaves, are naturally thin enough to make observation easy, even at high powers. But if the science of microscopy were restricted only to materials that nature had made ready for observation, our knowledge of biology and most of the other sciences would be meager indeed.

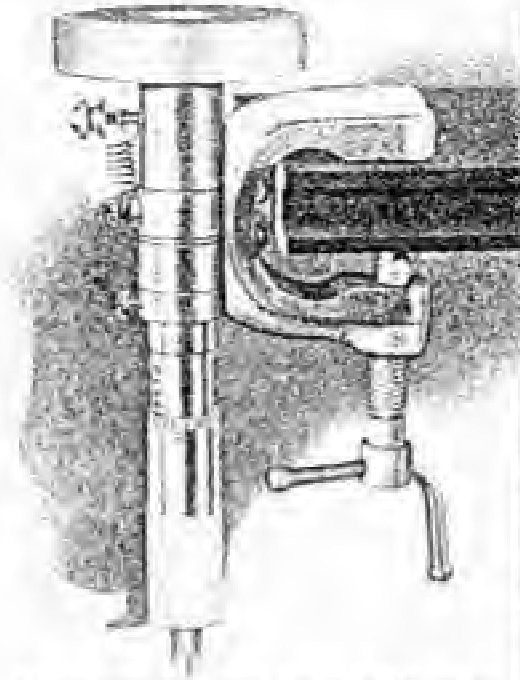
Early in the development of the microscope, it was found necessary to slice such things as plant stems into thin sections, in order to make visible the mysteries hidden in them. Such slicing was, at first, done entirely by hand. In fact,

the art of free-hand sectioning is one that still is very useful to the microscopist, whether amateur or professional.

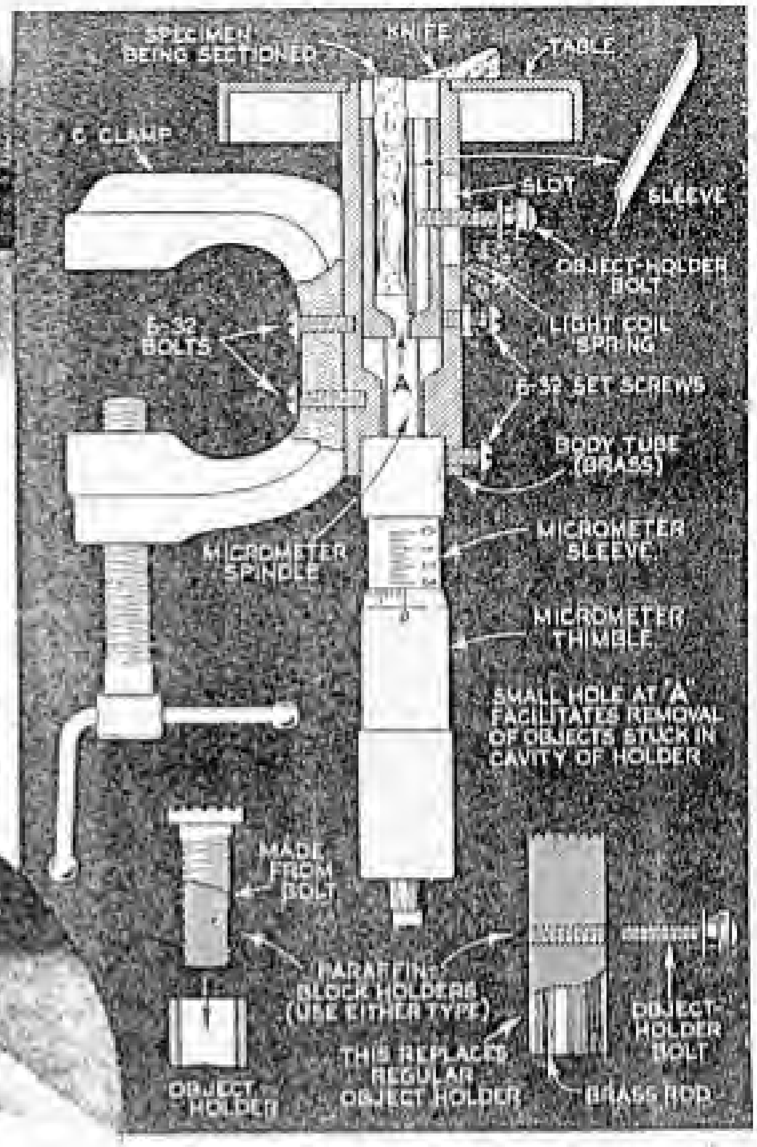
One popular way of cutting sections by hand is to hold the specimen—say, a plant stem—between the thumb and index finger of one hand, in such a way that the razor slides over, and is guided by, the thumb nail and side of the finger. Some workers find it convenient to lay the stem on a slab of cork or other material that will not damage the razor blade, hold it with the thumb and finger, and slice it very much as you would cut a loaf of bread. Here, too, the thumb nail can be used to guide the razor.

Although free-hand sectioning is satisfactory to a surprising degree when done by a skilled worker, it is much easier to get first-class results by employing a mechanical device for holding the material being cut and for feeding it past the sectioning knife with such control that the thickness of each slice can be determined very accurately. Such a slicing machine is called a microtome, meaning "small-cutter."

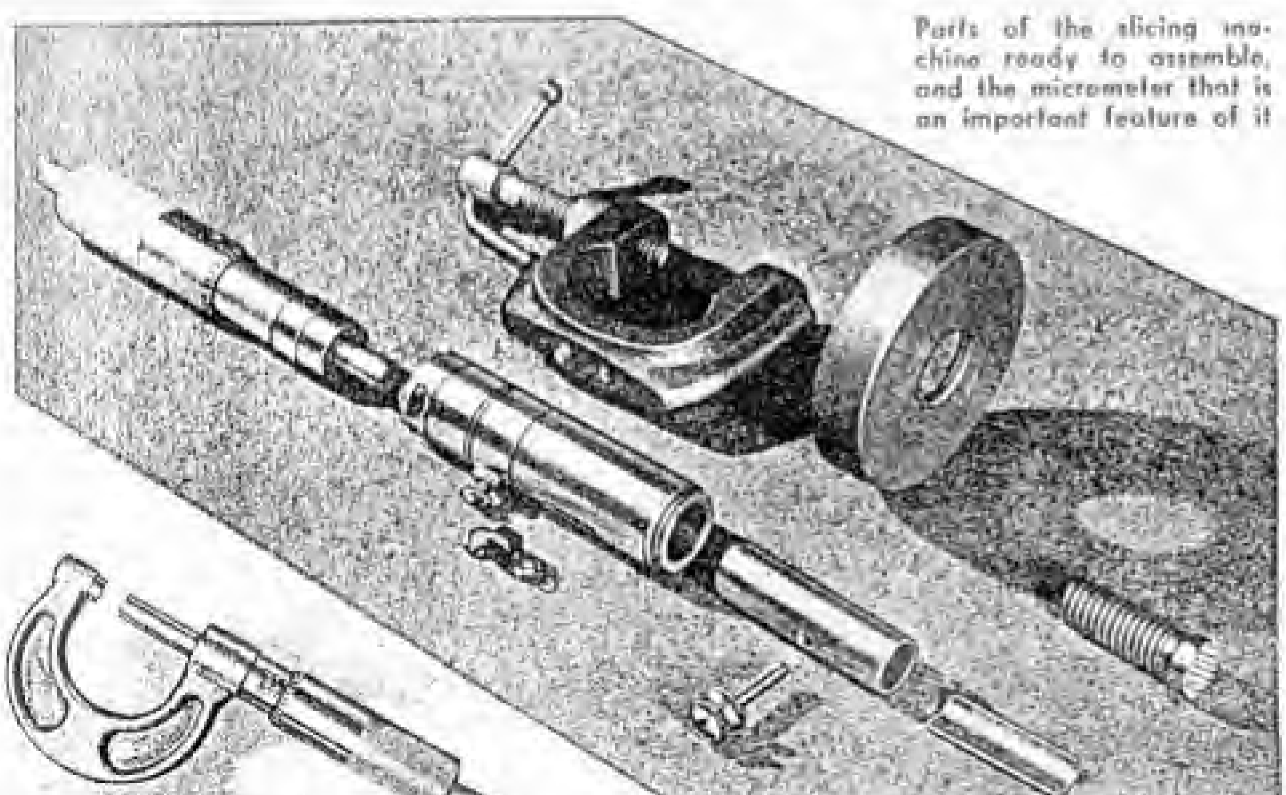
You can, of course, purchase professional microtomes for making sections. A good hand microtome costs about $16.50, while the price of a highly refined mechanical one may run to $600 or more. These machines are built with



Microtome fastened to a table edge by means of its C-clamp attachment. Below, hand-held type in operation



Details of the slicing tool showing how it is assembled from a fifty-cent micrometer



Parts of the slicing machine ready to assemble, and the micrometer that is an important feature of it

the precision of microscopes, for they work to tolerances of less than a micron (one thousandth of a millimeter).

It is not at all difficult for the amateur microscopist to build his own slicing machine. Although the construction will be much easier if a metal-working lathe is available, it is possible to turn out a satisfactory job with ordinary tools.

The instrument consists essentially of a body tube, inside of which is a sliding tube or "object holder" that grips the material being sliced. The upper end of the body tube is fitted with a circular platform over which the knife blade slides, and the lower end is provided with a micrometer screw to control the thickness of the sections. Dimensions are given for the various parts, but these can be varied to suit your own ideas or materials. Since the metric system of measurement is standard for microscopes and similar instruments, dimensions will be given in centimeters and millimeters. However, if you want to change them into the English system, a millimeter can be taken as equal to 0.03937 in., and a centimeter to 0.3937 in. An inch equals approximately 2.54 centimeters, 25.4 millimeters, or 25,400 microns.

The body tube is turned from brass. It is 6.5 cm. long and 18 mm. outside diameter, with an inside bore of about

12 mm. The bore extends to a depth of 48 mm. The upper end of the tube (open end of the bore) is provided either with threads or with a collar, to enable the circular cutting table, 50 mm. in diameter, to be attached. This tube, while best made on a lathe, can be simply a length of brass tubing of any convenient diameter. The tube walls ought to be no less than 2 mm. thick.

Sliding inside the bore is the object holder, similarly made from brass. It has an outside diameter that permits it to fit very snugly in the bore, and a length of 3.6 cm. Wall thickness should be about 1.5 mm. In the microtome illustrated, this part has an outside diameter of 12 mm., an inside diameter of 9 mm., and a length of 3.6 cm.

Beginning about 15 mm. from the top of the body tube, and extending downward for another 15 mm., is a slot in which a 6-32 machine bolt will slide freely. With the object holder inside the body tube, and with the upper ends of both tubes even, make a punch mark on the object holder at the upper end of the slot, and drill and tap it to receive a 6-32 bolt. This bolt, which should be fitted with a knurled nut or head to make it easy to turn, does several things: it serves to clamp the object in position, it limits the upward movement of the object holder so that the knife will not strike the metal, and it serves as an anchorage for one end of a small coil spring whose purpose will be described later.

Obtain, at your local hardware or dime-and-dollar store, an inexpensive micrometer of the type illustrated, and of a size that measures diameters up to one inch. This costs about fifty cents. With a back saw, remove the curved frame as shown, and file or turn the end of the cylindrical, graduated sleeve until it is uniformly round, and perhaps slightly reduced in diameter. Drill or bore out a socket in the lower end of the microtome body tube to receive this end of the sleeve, to a depth of about 7 mm. The sleeve should fit snugly in the socket. It is held by one or two set screws extending through tapped holes in the body tube. One of these screws can be used to anchor the lower end of the coil spring, although in the photographs another screw, farther up the side, is shown.

The movable spindle is 6.35 mm. (¼ in.) in diameter. To make room for it in the body tube, drill a hole about half again as large, connecting the bore and the socket for the micrometer sleeve. Now, with the parts assembled, you can feed the object holder upward by turning the thimble (knurled, movable part) of the micrometer to the right. It would be better if a

micrometer graduated in millimeters could be used, so that readings in microns would be easy; but it happens that these inexpensive micrometers are graduated in the English system. Around the edge of the thimble are twenty-five divisions, every fifth one numbered. Each of these divisions represents 1/1000 in., or 25.4 microns. It is easy to estimate fractions of a division, such as ½ or 1/3, when feeding the specimen.

THE table over which the knife slides is simply a rigid metal disk fitted to the upper end of the microtome body tube. In the instrument shown, this table was turned from an old carpet-sweeper pulley, and is made of some tin or lead-base alloy. It is attached to the body tube by means of threads and anchored with solder. A better arrangement is to employ a brass disk securely soldered to the tube. File, turn, or grind the surface of the disk and the end of the body tube at its center, to make them perfectly flat and even. If the end of the object holder projects above this flat surface when the micrometer feed is turned upward as far as the bolt in the side slot will allow, remove the holder and shorten it by removing some metal from the upper end. The knife blade should clear this end by a good fraction of a millimeter.

The coil spring (or a rubber band) extending between the object-holder bolt and one at the lower end of the body tube serves to keep the micrometer spindle and the bottom of the object holder in contact, which results in even feeding and uniform thickness of sections.

Specimens that are fairly rigid, such as twigs and stems, can be clamped in the object tube merely by screwing the clamping bolt against them. Softer specimens would be penetrated by the bolt, and not held rigidly. For such materials, make a rectangular sleeve or jaw, slightly curved, that will drop into the well of the object holder, between the object and side where the clamping bolt enters. The end of the bolt presses against this sleeve, and exerts uniform pressure along the length of the well.

LATER you will want to use the microtome to cut paraffin sections. That is, the object to be sectioned will be embedded in a small block of paraffin, which is fed past the knife so that paraffin and object are sliced at the same time. To hold such paraffin blocks, make a fitting that will drop into the well of the sliding object holder. The one shown was made from a machine bolt. A flat place was filed in the threaded portion to receive the end of the clamping bolt. The head was split with a back saw to reduce it to a thickness of about 3 mm., and turned to a diameter equal to that of the outside of the object holder. The face, or upper surface when the fitting is in place, was grooved with a file, to make the

Don't Handicap Your Instrument with Dirty Lenses

DIRTY lenses are a common cause of poor performance in a compound microscope. If you see spots when you look into the instrument, the chances are that the eyepiece lenses are dirty. Rotate the eyepiece while looking through it and if the spots rotate too, you can be certain the trouble is there. Dirty objective lenses cause general loss of definition.

Make it a habit to remove the objectives periodically and clean them, especially the inner surfaces where dust falling down the tube settles. With a fine camel's-hair brush, you can lift off much of the dirt without scratching the glass. Finally, after the gritty particles have been removed in this way, clean the lens surfaces with special lens tissue, or with a *well-washed* piece of linen or chamois skin. Wipe gently with a circular motion, and if necessary moisten the glass by breathing on it.

Never use alcohol, water, or other liquid for cleaning high-grade lenses, except when you employ xylol to remove immersion oil from high-power objectives. If you clean an oil-immersion objective immediately after it is used, you generally need nothing more than lens paper. Revolve the lens against the paper, so that the glass is wiped with a circular motion.

Much trouble can be avoided by keeping dirt from the lenses in the first place. Do not attempt to take an objective apart, unless it is of a type that is divisible to produce different magnifications. Keep removable objectives in their screw-capped containers when not in use. If you do leave them attached to the microscope, store the instrument under a bell jar or in some other dust-tight container when not in use.

paraffin stick better. In use, the holder is warmed and pressed in contact with the paraffin block, which is then trimmed flush with its edges. You can, instead of making such a fitting, fashion a length of cylindrical rod, drilling and tapping it for the bolt entering through the side slot. This rod takes the place of the hollow object holder.

THE microtome at this stage is complete, if you want only a hand-held instrument. But for a few cents and a few minutes more, you can make it fasten rigidly to a table. Obtain a small C clamp of a type similar to that shown, and file or saw the back edge of the frame until it is flat enough to rest firmly against the side of the microtome body tube. Drill two holes through the frame to receive short 6-32 machine bolts, which enter threaded holes in the tube. The sliding handle in the clamp illustrated was bent at right angles, to reduce its length so it would clear the micrometer thimble.

Much of the success in sectioning depends upon the knife used for cutting. Special microtome knives are obtainable, but costly. An old-fashioned, straight-back razor, if sharp, will do nicely; or you can buy, for a little over three dollars, a special sectioning razor. This is similar to the ordinary razor, but has a straight edge and one side that is flat. Cheapest of all, and capable of very accurate results, are ordinary safety-razor blades. These should be clamped in a holder that will keep them straight and rigid, or the cutting edge will have a tendency to bow down as it passes over the hole in the center of the microtome table. Some types of paint scrapers which employ razor blades can be used.

It is a good idea to select the best blades out of a given assortment, by examining the edges with your microscope for sharpness and uniformity.

Now that your microtome is complete, you can try it out on a few easily obtained specimens. Some materials can be cut directly without special preparation, others are best sectioned after treatment to harden or soften them, or after they have been surrounded by some supporting material.

PERHAPS the best objects to start with, in acquiring skill with your newly made microtome, are stems and roots of plants. By cutting sections in various directions—cross sections, longitudinal sections, and so forth—you can learn much about plant structure. Cross sections are generally the most interesting, and make particularly beautiful objects when stained with methylene blue, eosin, and other dyes.

When sectioning hard, woody stems, or pieces of lumber (which are parts of larger stems), you usually can clamp them in the microtome without providing any surrounding material to support them. Softer stems have to be supported by some auxiliary material. There are various suitable materials for this form of simple embedding. Generally, cork is used for fairly rigid stems and similar objects. For the more delicate materials, you can use dry elder pith, pieces of raw carrot or potato, or in fact anything that will provide the necessary rigidity and at the same time can be cut easily.

TO MOUNT a stem so that it will be supported by, say, a cylinder of cork, trim the cork until it will enter the object holder of the microtome. Then split the cork cylinder in two along its axis, and with a sharp knife cut two small V notches so that, when the halves are put together, the notches will form a rectangular hole. The shortest diameter of this hole should be slightly less than that of the stem. Place the stem between the halves, like a "hot dog" in a bun, and clamp the sandwich in the microtome. Take two or three fairly heavy cuts to square up the end, and then make the sections, cutting them as thin as possible.

Instead of the V grooves in the halves of the embedding material, you can cut semicylindrical ones, if you like. Perhaps a small carving tool would be ideal for this. Still another way is to punch or drill a hole in the cylindrical plug without splitting it, and push the stem into this hole.

If you want sections of wood, it is best to cut them from the green stem rather than from seasoned wood. Cut the stems into short lengths, and soak them for several days in strong alcohol, to remove the resin. Then soak them a few more days in water, to dissolve out any gummy matter present. The stem should then be fairly easy to cut. If you want to section seasoned wood, split pieces to a size that will enter the microtome, and soak them for several days in water, or boil if necessary. Further treatment with alcohol and again with water, as in the case of green stems, usually will soften the wood still further.

IN CUTTING stems and the like, curling can be reduced or prevented by having the stems and the knife blade wet with water. The section will float up on the blade and lie flat. It can be washed off by dipping the blade in a jar of water, or it can be lifted off and transferred to a dish of water with a small camel's-hair brush. Treatment of the thinly sliced specimen after that may take any of various forms. For immediate inspection under your microscope, the stem section can be mounted in glycerin, or in a weak alcoholic solution.

HOW TO TAKE PICTURES *with your* Microscope

POPULAR SCIENCE MONTHLY
APRIL, 1933

Pictorial Records of Things the Unaided Human Eye Can Never See Are Easily Made With the Apparatus Described Here

By BORDEN HALL

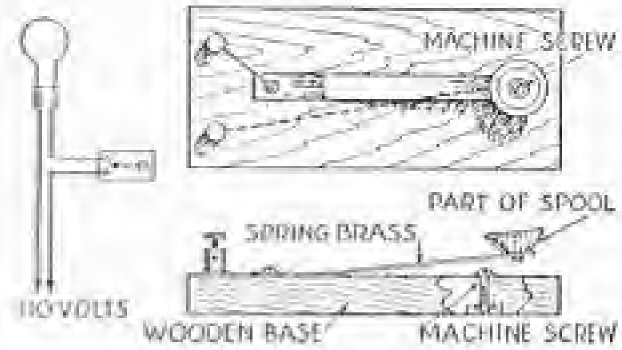
IN THE world of the microscope, as in our ordinary world, we can take pictures as we travel. It matters little what kind of a microscope we use so long as it has powers beyond those of ordinary magnifying glasses. Of course, if we are going to push on into the more inaccessible regions of this tiny world, we must have an instrument with a power of at least one hundred diameters; that is, a microscope that will magnify 100 times. This is 200 diameters less than the power of the instrument originally recommended for beginners, but a microscope of this size will open up a series of detailed and wonderful sights.

The type of camera used for making photomicrographs is unimportant, for the simple reason that we do not make use of its lens. On the contrary, we remove the lens. The microscope itself forms the lens system and the picture we see when we bring our eye to the ocular is projected on the film of the camera. In effect, the microscope acts like a little magic lantern; instead of projecting pictures upon the wall, we project them upon a sensitive photographic film.

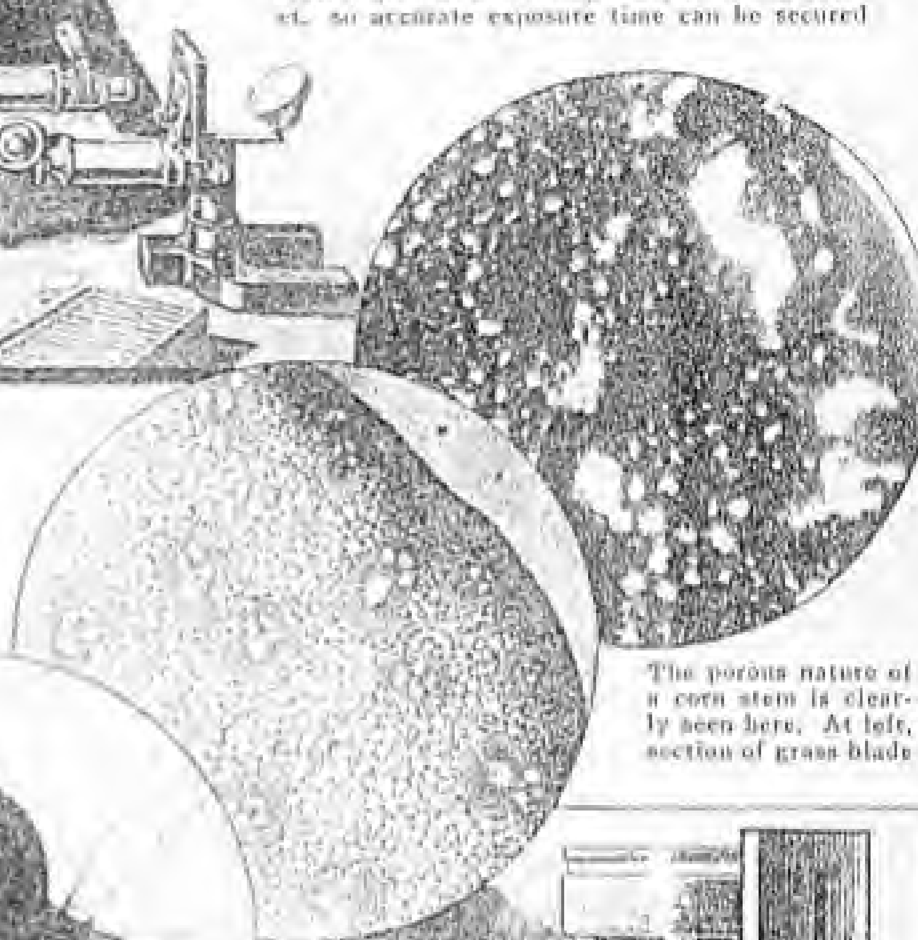
Although almost any type of camera except the very smallest may be used, a plate camera that takes 4 x 5 or 5 x 7 pictures is best suited for use with a microscope. Such cameras not only give good sized views but permit us to bring the image to sharp focus on the ground glass plate before the film is exposed. However, with a little ingenuity, the owner of a smaller camera can get good microscopic pictures.

In this work fine and careful focusing is essential for we are dealing with focal lengths so short that hairsbreadth dis-

DRAW YOUR OWN PICTURES
Micro-drawings, like the one of the amoeba, upper left, can be made by any one, as illustrated above, if the mirror and brass clip device, shown at left, is attached to microscope



Drawings show how to rig a key to a lamp socket, so accurate exposure time can be secured



The porous nature of a corn stem is clearly seen here. At left, section of grass blade

more cumbersome. A focusing screen is absolutely necessary but the owner of a small film camera can remove the back of the instrument and fit it with a ground glass for focusing. If ground glass is not available, a piece of ordinary tracing cloth of the kind used by draughtsmen can be used. Since it is necessary to remove and replace the film in this process, the work must be done in a dark room. Each time the film in the back of the camera is brought forth, the illumination will have to be cut off from the microscope.

WE REMOVE the lens from the camera and pull the tube of the microscope back to a horizontal position so the eyepiece of the microscope butts right up to the hole in the camera bellows formerly occupied by the lens. Around this crude joint we wrap some soft black cloth free from dust.

The light for the microscope is arranged from above. Throwing a black cloth over our head, we peep into the ground glass, at the same time manipulating the microscope mirror under the stage until the ground glass is illuminated with an even light.

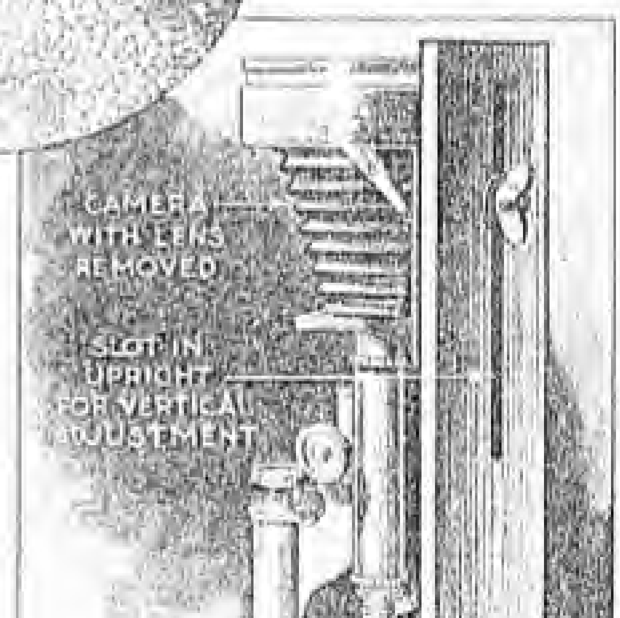
Next a slide is inserted and we continue with our adjustments, focusing the microscope and manipulating the bellows of the camera until our picture is of the proper size and the proper sharpness. To do this, we may find it necessary to raise the camera upon books until just the proper height has been reached.

WHEN the focusing has been completed, the light source is turned off and the plate or cut film is inserted. Now we come to the matter of exposure which

With the light arranged so that it fell from above, this picture of a mosquito's head was made. Note strength of the fine details

brings us face to face with the choice of film. The newer films, with high color sensitivity, are best for microscopic work. If cut film is used, panchromatic film will be found both fast and faithful, but here photographic skill is required, to a greater extent anyway than if the slower emulsions are used. If ordinary film is used, several seconds' exposure may be given with a low-power electric light, say forty watts. But how are we to control this matter of exposure when we have to manipulate a crude switch on a lamp socket in place of a precise camera shutter? The writer has found that a small electric key connected in series with the electric light solves the problem. The details of this little key are given in the drawing.

The outfit that we have been describ-



This diagram gives the details of a camera and microscope stand with which fine adjustments are possible so that unusual photos can be taken

ing is rather crude. Those who wish to pursue microscopy in a serious way undoubtedly will wish to construct more

elaborate equipment. In the drawing on this page are details of a holder that will accommodate both a microscope and a camera. This is made of soft pine. The board upon which the camera is mounted is provided with a slot so the camera may be moved up or down. This not only permits more rapid adjustment but insures against movement of the camera when the plate or film is inserted and also provides a convenient focusing position.

IN WORKING with this equipment, a little practice will be needed before you can adjust the size of the image correctly upon the plate. If the image on the ground glass screen is not large enough or does not completely fill the plate, simply move the bellows of the camera out and refocus until the size is correct. Determining the proper exposure also may be a little difficult at first so it is best to make a test by exposing and developing a few films or plates. Exposure depends upon two factors—the nature of the object and the power of the illumination. A fly's wing, for instance, is transparent and does not need as long an exposure as do specimens that pass less light.

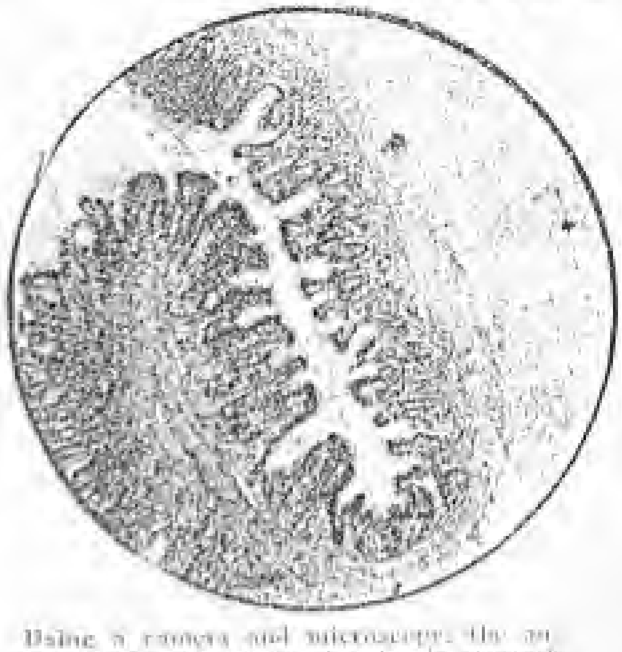
As we gain in skill, we find that we can photograph opaque objects as well as transparent ones. If, for example, we wish to photograph a surface, we arrange our illumination above the stage of the microscope so that part of it strikes the surface and is reflected off and up through the lenses of the microscope system.

Photography of surfaces is of vast importance to industry. Much of our progress in the compounding of new alloys in the past few years has resulted from the study of metallic structure made possible by means of the microscopic examination of surfaces. Each metal alloy tells its own story under the lens, and although the microscopist in this field cannot peer down into the body of his specimens, by treating these specimens with certain acids and alkalies and by polishing, he can gain a complete knowledge of their structure and the effects upon this structure of the addition of various materials. Metallurgy owes a great debt to the microscope. Modern steels and the industrial progress that has come from them would have been impossible without the careful work of the metallurgist using a microscope.

ALTHOUGH the amateur worker cannot gain access to the field of moving photomicrography, he will be interested to know that bacteriology and medicine have received tremendous help from this source. It is one thing to see bacteria dead in pictures and quite another thing to make moving pictures of them for study. The habits of a number of deadly organisms have been discovered by this use of the microscope and camera.

That the amateur who does not have a camera may still make picture records of his microscopic studies, the writer has included a picture showing how drawings of microscopic objects may be made and colored with water colors, by persons of no training in art. By this method tiny sketches may be made as notes, or with a little more trouble, accurate detailed drawings may be prepared. To do this a small mirror of good quality is cut about one inch square. This is held in a small brass strap and placed on the end of the microscope at an angle of forty-five degrees. If the operator inclines the microscope to a horizontal position and looks down upon it so that one eye strikes the mirror and the other eye strikes the paper upon which the picture is to be drawn, the drawing of the object on the slide will be found to be very easy even to an unskilled artist. Water colors used to color photographs are excellent for use in coloring these micro-drawings.

Half of the fun in microscopy comes from the preparation and mounting of specimens. Merely to take a specimen and seal it between glass slides, is not enough. Such a makeshift will last for a few hours but what we want are specimens that will last for years. Hence, the necessity of making mountings that will be free from spore infested moisture. Indeed the elimination of moisture is the big problem.



Using a camera and microscope, the author made this photo of a frog's stomach

WHILE it is extremely easy to mount such common things as a fly's wings and a piece of onion skin, it is not so easy to mount more complicated structures that will not pass sufficient light to permit of their examination under the microscope. To do this we must cut slices of these objects so thin that they will pass enough light to reveal what is inside them. Such thin slices are prepared by a little instrument that works on the same principle as the meat slicer in butcher shops. Such an instrument is called a microtome and it may be easily made by one in possession of a few household tools and average ability in using them.

Armed with a microtome and a knowledge of the preparation of slides, which will be discussed next month, we shall be in a position to make our collection of photomicrographs much more extensive and interesting.

POPULAR SCIENCE MONTHLY
SEPTEMBER, 1933

Homemade PROJECTOR *throws* Microscope "Movies" on Screen

By Morton C. Walling

CAN you imagine anything more thrilling than a germ's-eye movie of our fantastic universe of the microscope? A living picture of that strange world of the amoeba, the spore, and the algae, thrown on a six-foot screen, revealing the daily habits of microscopic actors as they fight, forage, and reproduce.

The amateur microscopist need not journey far to view this novel moving picture show. Your sitting room can be the theater, a white wall the screen, and a simple homemade micro-vivarium the projector.

With this inexpensive piece of apparatus, you can produce your own dramas of the microscope in true Hollywood fashion. Strife, death, and tense adventure will unfold before your eyes in an ever-changing pattern of queer microscopic life. And for all this, five dollars spent for materials will be your ticket—good for a lifetime.

Until you have viewed a drop of water as the micro-vivarium projects it, you have missed the most beautiful and interesting of all sights. Tiny living creatures, enlarged until they dwarf even the largest gold fish, swim and dart across a giant circle of light. Fantastic animals and grotesque plant life parade before you like a scene viewed through the porthole of Jules Verne's magic submarine.

But let us get on with our work. You will have plenty of time to marvel at this mysterious wonderland at first hand.

Although you will have to buy a few of the materials for your micro-vivarium, the objective lens of your microscope will form the most important part. The rest of the equipment consists of a baseboard, two inexpensive eyeglass lenses, an improvised water cooler cell, and a homemade arc lamp.

A Startling Vista of Living, Moving Creatures Projected on the Screen

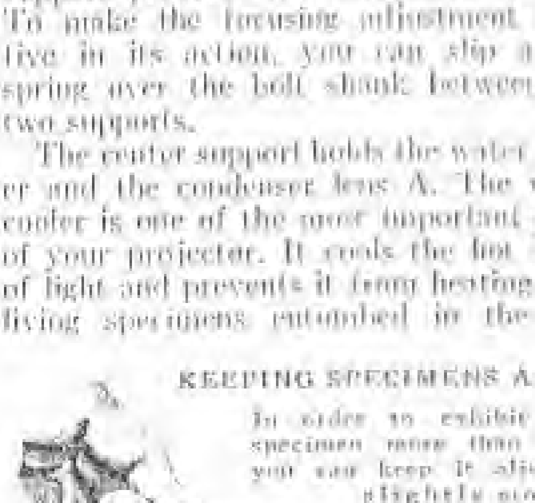
Since the two condenser lenses (A and B) are to be arranged so they are movable, the exact position of each support on the one by six-inch by three-foot baseboard is unimportant. For convenience, the center support can be placed approximately in the middle. All three supports can be assembled and fastened in place with brads or screws and glue.

As you can see by studying the photograph and drawing, the main front support performs a double function. A projecting arm at the rear takes the movable condenser lens B and the support itself contains a metal plate having a one-fourth inch aperture drilled in its center. Naturally, the aperture must be placed over a larger hole in the wood support. Two spring clips fastened on each side of the plate serve to grip the ends of the microscope slide and hold it in place over the aperture.

In front of this main front support and attached to the same base block is an adjustable spring holder for the objective lens of your microscope. You can make this by fastening a one-half by two by six-inch wood block, having a hole drilled through it to be a tight fit for the upper end of your microscope objective lens, to a two-inch wide strip of springy metal. Be sure the support is long enough to bring the center of the objective in a direct line with the condenser lens and aperture. Everything must be carefully lined up if you want to get the best results.

A wing nut threaded on the projecting end of a long bolt passed through horizontal holes in the main support and objective holder forms the focusing adjustment for the microscope lens. A lock nut screwed up tight against the front face of the main support prevents the bolt from turning. To make the focusing adjustment positive in its action, you can slip a coil spring over the bolt shank between the two supports.

The center support holds the water cooler and the condenser lens A. The water cooler is one of the most important parts of your projector. It cools the hot beam of light and prevents it from heating your living specimens entombed in the tiny



KEEPING SPECIMENS ALIVE

In order to exhibit your specimen more than once, you can keep it alive by slightly moving cover glass and adding occasionally a little more water

glass slide that will form your microscope aquarium.

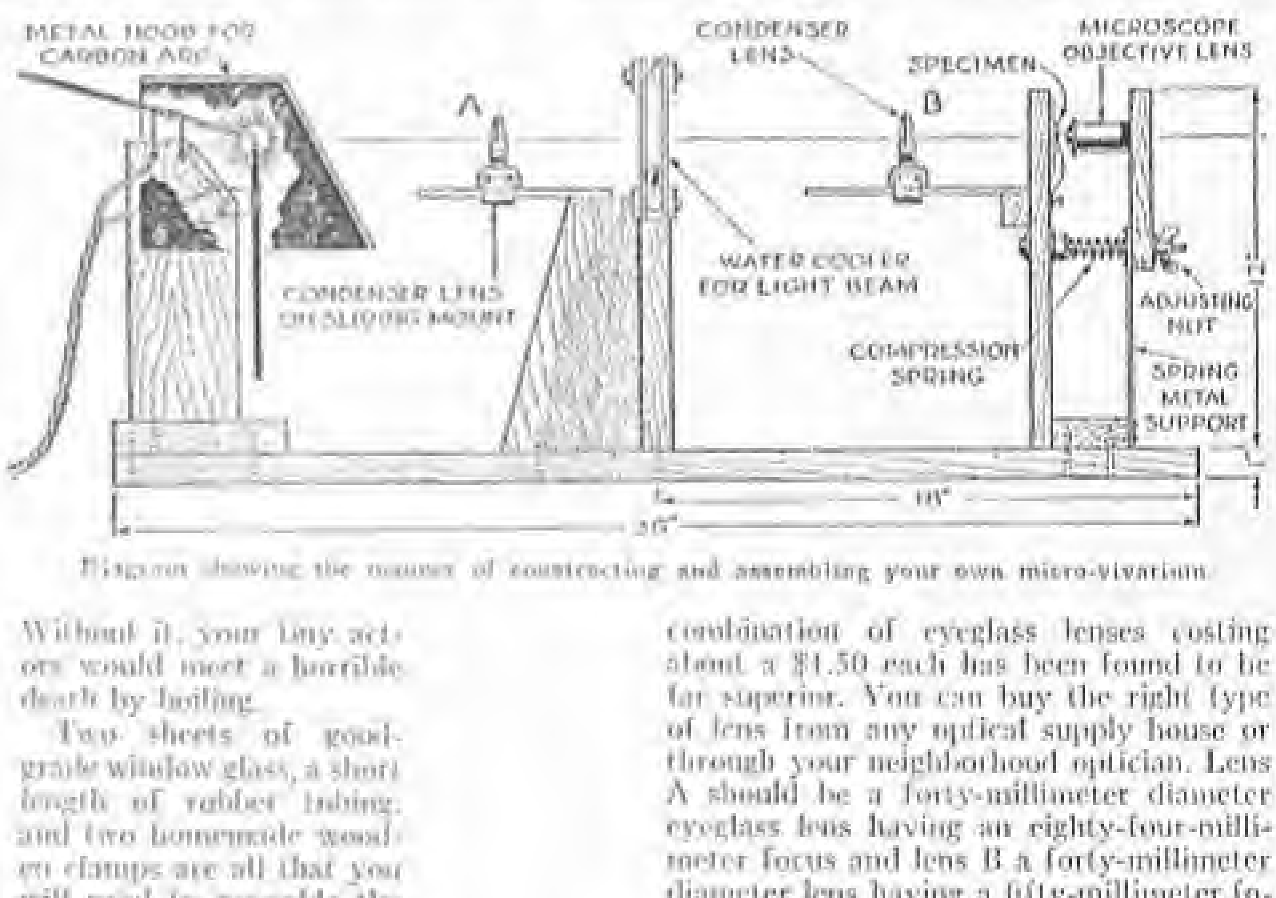


Diagram showing the manner of constructing and assembling your own micro-vivarium

Without it, your tiny actors would meet a horrible death by boiling.

Two sheets of good-grade window glass, a short length of rubber tubing, and two homemade wooden clamps are all that you will need to assemble the cooling cell. Bend the tubing U-shaped, place it between the two pieces of glass, and hold the parts together with the clamps. The U-shaped tube, pressed tightly between the rectangles of glass, will form a water-tight well. Using brads or screws, fasten the water cell in place in a shallow notch cut in the front of the center support.

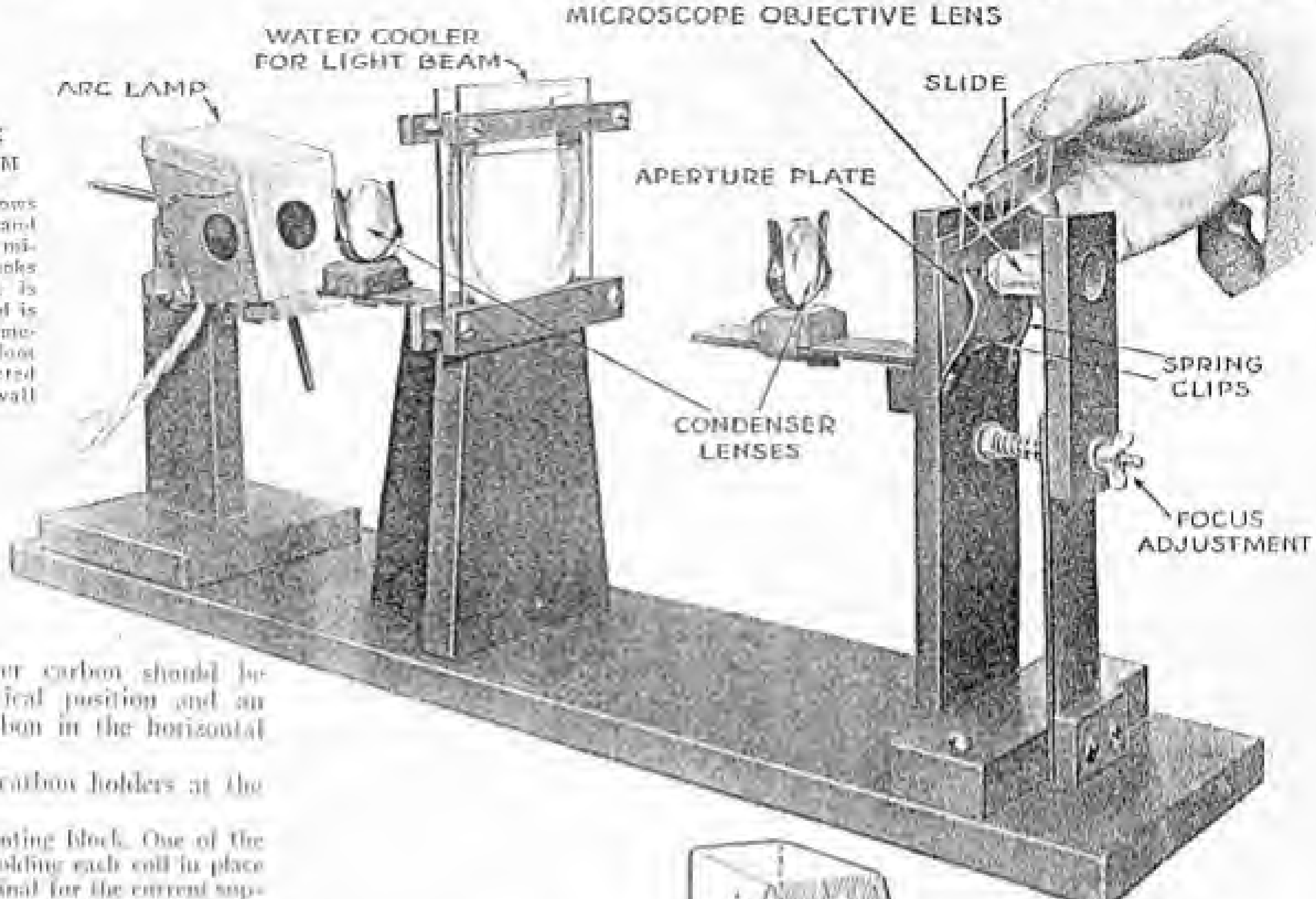
Although simple biconvex lenses were used as the condensers in the original, a combination of eyeglass lenses costing about a $1.50 each has been found to be far superior. You can buy the right type of lens from any optical supply house or through your neighborhood optician. Lens A should be a forty-millimeter diameter eyeglass lens having an eighty-four-millimeter focus and lens B a forty-millimeter diameter lens having a fifty-millimeter focus. A lens set of this type can be used with either an eight- or a sixteen-millimeter objective lens.

For the light source, you can use any form of arc light you may have on hand (P.S.M., July 30, p.99), or you can make one from scraps of wood and metal and two short lengths of stiff wire.

If you follow the inexpensive arrangement shown, your first job will be to wind the stiff wire into two tight coils that will be a close sliding fit for the type of carbons to be used. If you have alternating current, both carbons should be of the eight-millimeter variety. With direct cur-

HOW TO MAKE MICRO-VIVARIUM

This photograph shows the essential parts and arrangement of the micro-vivarium as it looks when completed. It is easily constructed and is lighted with a homemade arc light. Six-foot images may be projected with it on screen or wall



rent a six-millimeter carbon should be placed in the vertical position and an eight-millimeter carbon in the horizontal position.

Mount the wire carbon holders at the top and front edge of the arc mounting block. One of the screws or bolts for holding each coil in place can be used as a terminal for the current supply. To protect the upper edge of the wood support from the intense heat of the carbon arc, sheath it in metal or asbestos. In fact, you can improve the construction greatly by substituting a piece of sheet asbestos for the wood.

As indicated, the electrical circuit consists of a suitable resistance, either fixed or variable, placed in series with the arc and the house lighting circuit.

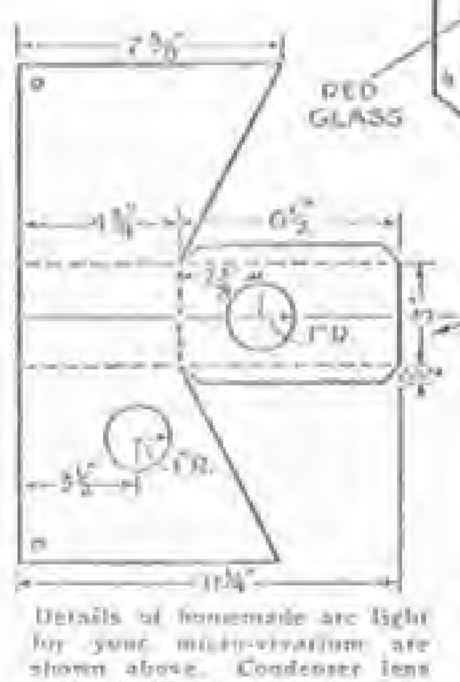
WHEN you have completed the sheet metal housing for your arc light and have fastened it in place with a single pivot bolt, in such a way that it can be lifted free of the carbons, you are ready to make the final adjustments on your micro-vivarium.

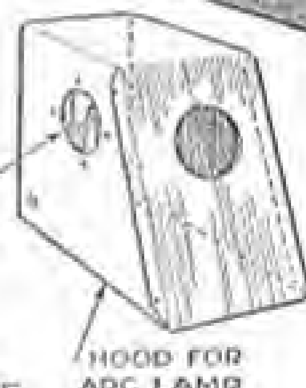
Fill the cooling cell with tap water, plug the circuit into the house supply, and adjust the carbons for the best arc. Be sure that the bright point of the arc lines up with the lens and aperture. Then, remove the condenser lens (B) nearest the objective and slide the other condenser (A) back and forth on its rail until the spot of light striking the back of the aperture plate is as bright as you can make it.

Leaving the lens A in that position, replace lens B and adjust it until the spot again reaches its maximum point of intensity. The beam of light passing through the condensers, the cooler, and the aperture then should be a brilliant spot on the lens of the objective.

Having made these final adjustments, you are ready for your first magic trip through an enlarged microscope land. Although the ordinary specimens in your slide library can be used in your micro-vivarium, the subjects they contain are dead and present none of the beauty and motion of the living variety. Besides, you can make up special aquarium slides that will show you the living things.

If you were successful in your attempt to capture the wily Volvox Globator described in a previous article (P. S. M., July '34, p. 56), you can prepare him as a subject for your first microscope movie. All that is needed is a glass slide of the type having a shallow well ground in its upper surface and a small cover plate. Aquarium slides are simpler to assemble than the cold storage variety. Place the water containing your actor in the well of the slide and slip the tiny cover glass into place. Capillary attraction will hold it in place without the aid of cement. Then place the slide under the aperture plate clips and adjust the objective lens until a sharp image of your captive is thrown on a white screen which is about six feet from the projector.

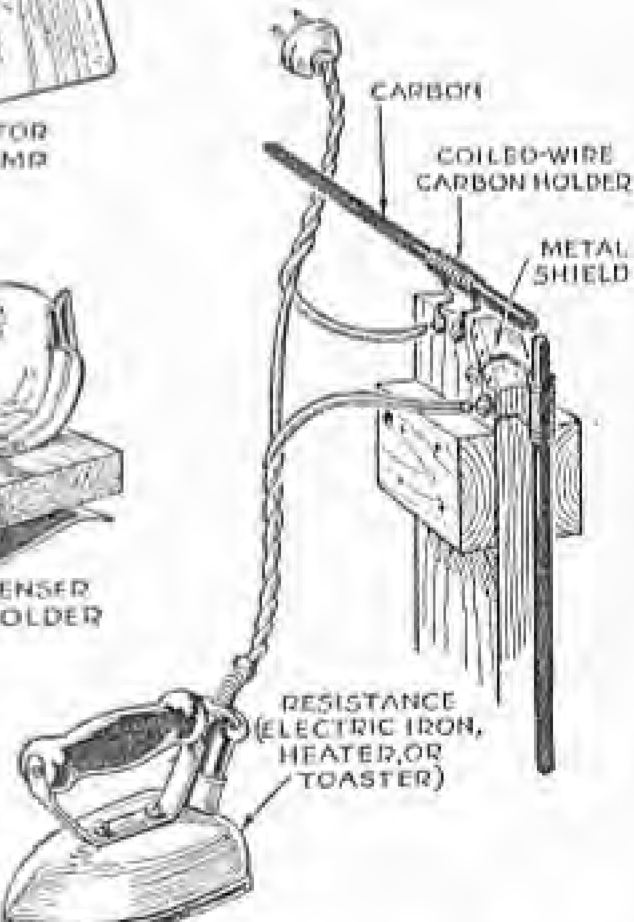




Details of homemade arc light for your micro-vivarium are shown above. Condenser lens holder is illustrated at the right

CONDENSER LENS HOLDER

YOU can make up your miniature projection aquariums as you need them. The well slides and cover glasses are so inexpensive you can keep a supply of them on hand.



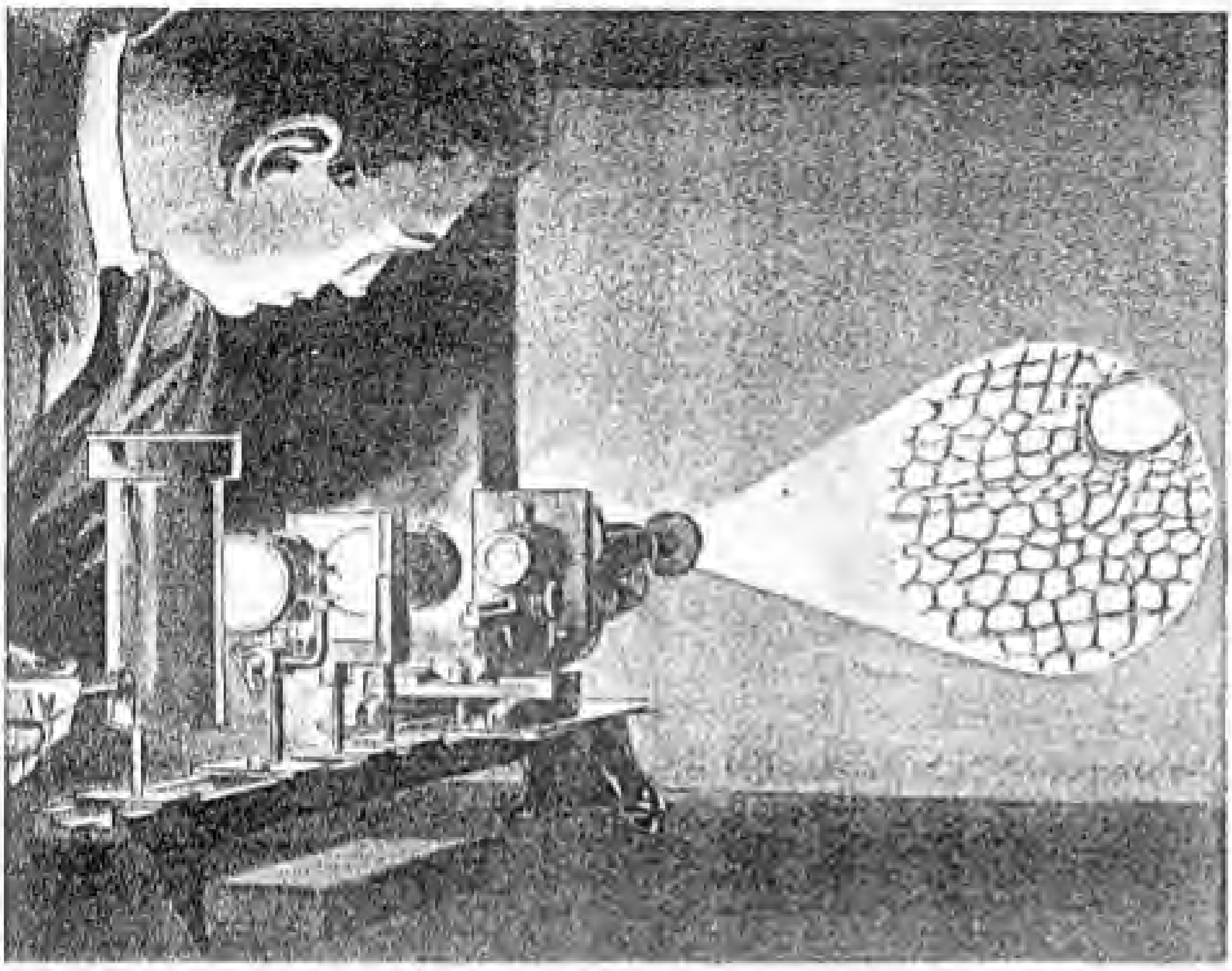
You can even store your specimen slides from day to day without killing the organisms they hold. Simply slide the cover plate down a trifle so the rim of the well is exposed. A drop of water taken from the same source as the original placed over the opening each day will keep your captives alive and healthy.

Hitch a Magic Lantern to Your MICROSCOPE

By MORTON C. WALLING

With Your Regular Instrument and a Few Odds and Ends, You Can Rig Up a Microprojector That Will Throw the Enlarged Images of Microscopic Objects on a Screen for Entertaining Large Groups of Your Friends

POPULAR SCIENCE MONTHLY SEPTEMBER, 1937



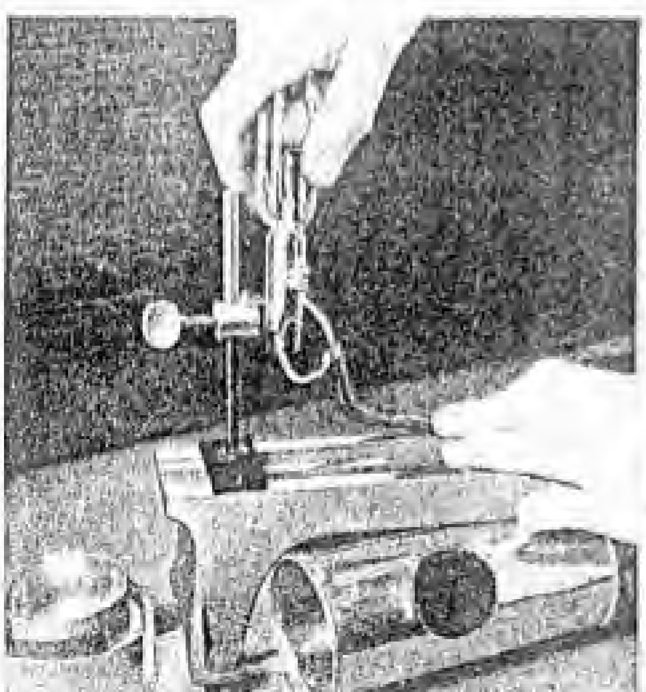
The microprojector in use. It has a polarizing disk on the microscope eyepiece for polarized light

THE microscope hobbyist who has reached the point where he wants to do something more than merely look into the eyepiece of his instrument and see a magnified image of whatever is on the slide, will welcome the increased opportunities that a microprojector brings.

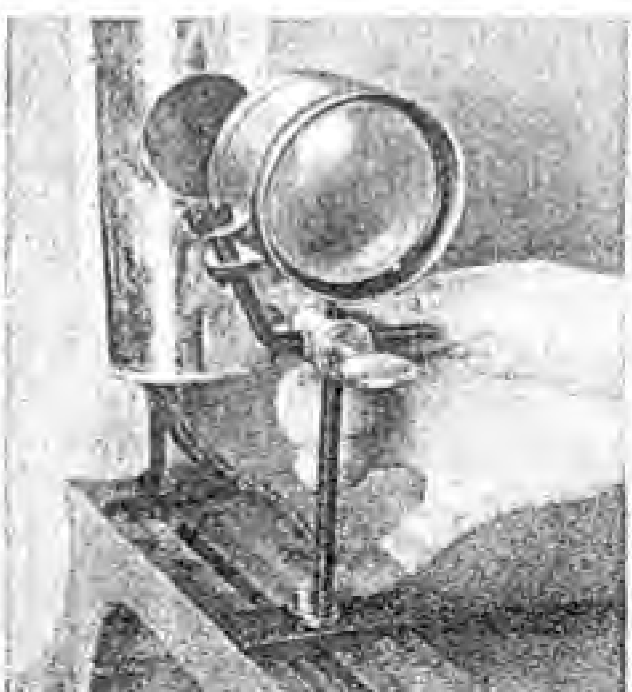
A microprojector is, essentially, very much like the lantern-slide or motion-picture projector that throws an enlarged image of a photographic slide or film on a screen. Its projection lenses are those found in a compound microscope, and its slides are the type ordinarily employed in microscopic observation. Unlike a lantern-slide projector, however, it projects an image of the original object, instead of a photograph.

A microprojector consists essentially of a source of strong light, a microscope, and a system of lenses for directing the light through the object and into the objective lens of the microscope. Generally, the tube of the microscope rests in a horizontal plane. In this position, it can be used with all permanent slides and with many live specimens swimming in water beneath a cover glass. However, for the projection of most live specimens, and other objects that might run or fall off the slide, a vertical microscope generally is better. In such a case, a mirror or prism, placed just above the eyepiece, intercepts the upward-moving light rays and directs them at right angles, so they will strike a vertical screen.

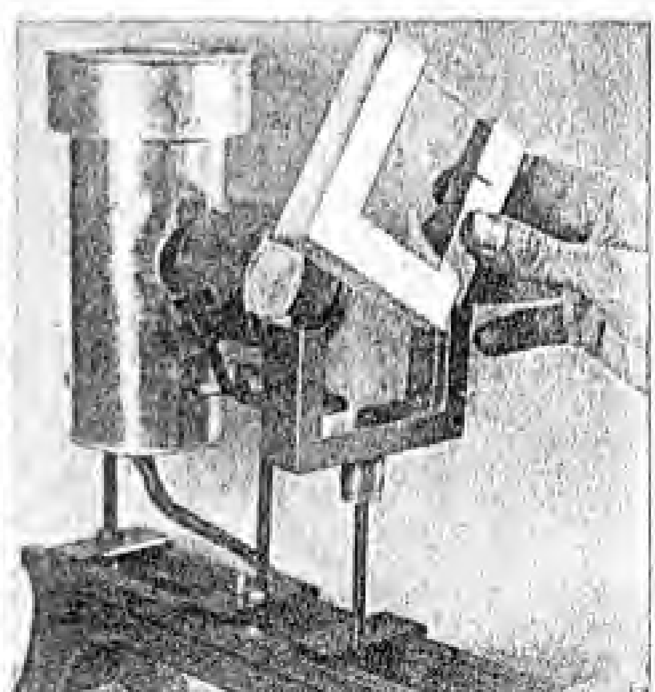
There are so many possible sources of light, so many kinds and arrangements of condensing lenses, and so many accessories such as polarizers and water cells, that it is next to impossible to describe an ideal microprojector. Therefore, I shall do the next best thing, and describe an instrument, built largely of inexpensive parts, that can serve as the basis for development of a projector to meet the specialized needs of the individual. This instrument, because of its flexibility, is



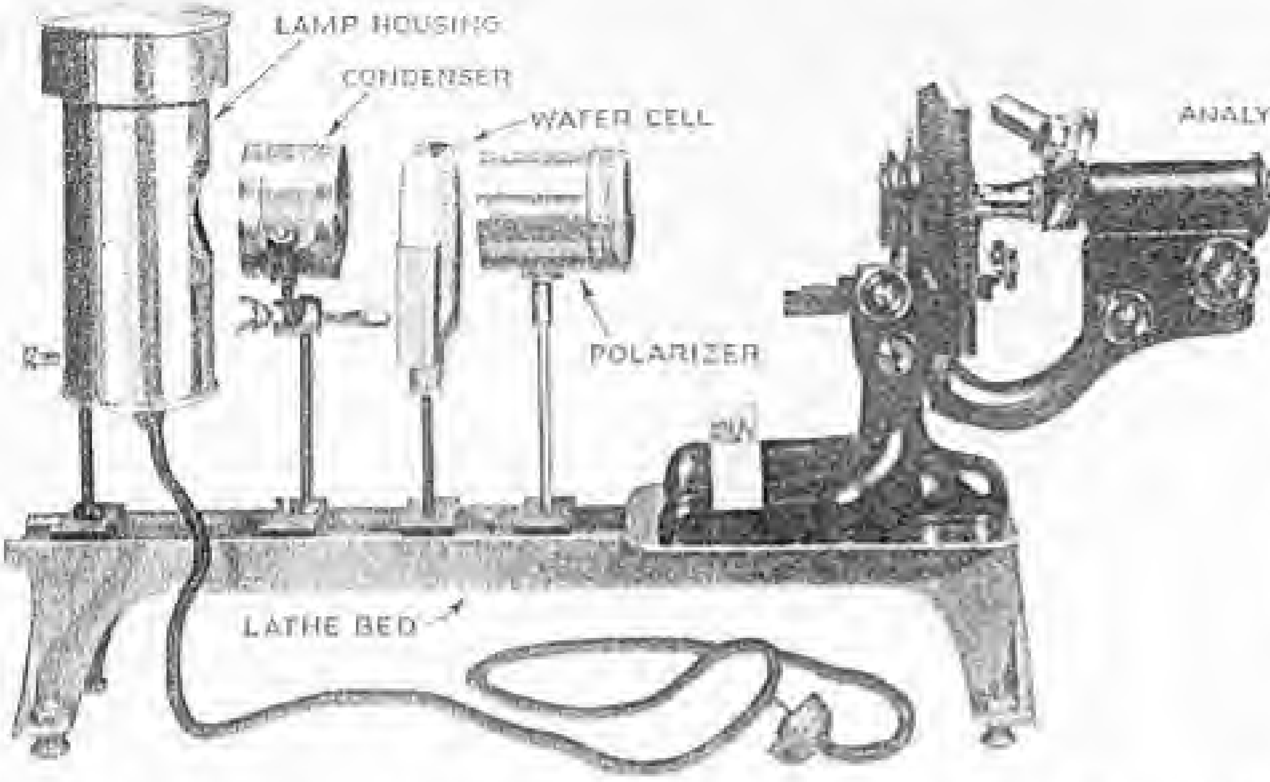
The lamp assembly, showing how the bulb is mounted on the lathe bed that forms the base of the instrument. Note the lamp housing



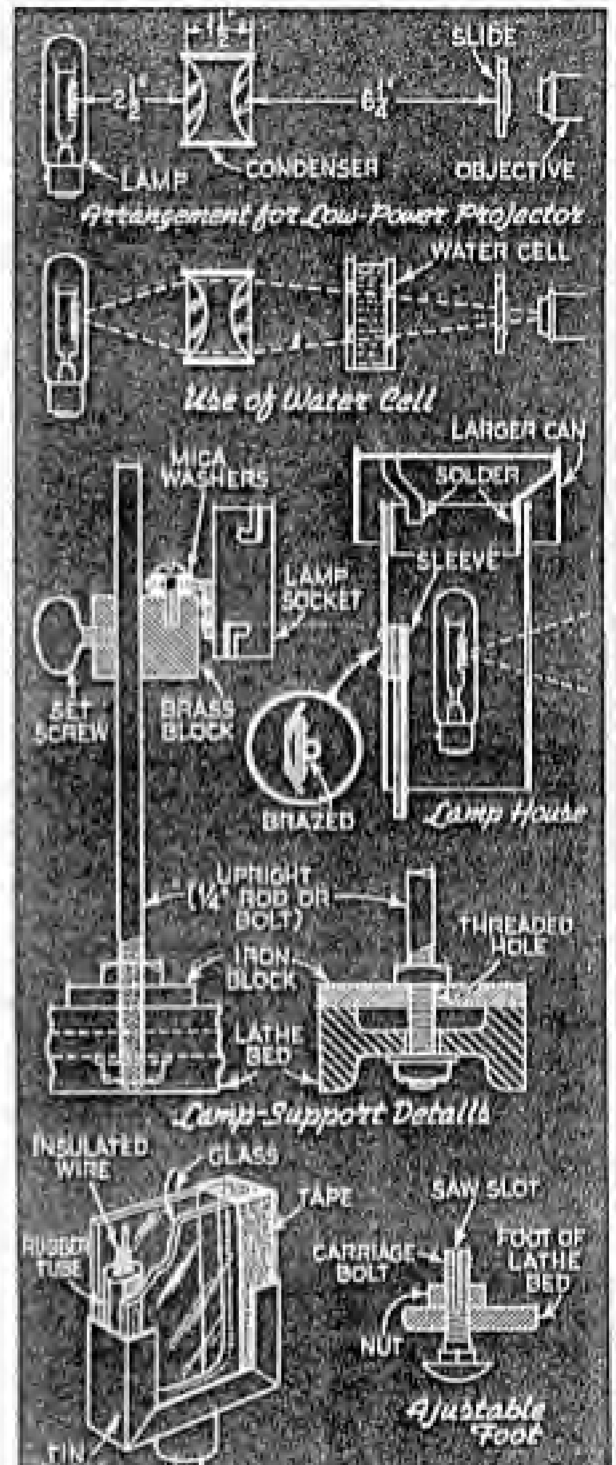
Two sixty-millimeter plano-convex lenses of three-inch focal length, held in a special mount, make the condenser unit shown above



To protect delicate slides from radiant heat, a simple water cell is interposed between the condenser and the specimen when needed



Assembly of the various units of the microprojector. Drawings below give construction details



in itself an excellent experimental project, for it can be used to try out various arrangements of condensers, and for other research.

Essential parts of the microprojector are: the base, source of illumination, condensing system, water cell, polarizing system, and microscope. Since you will, no doubt, want to use the microscope you already have, it really should be considered the starting point. The height of the center line of the tube above the bed of the instrument, when the tube is horizontal, determines the distance from the bed to the centers of the lamp filament, condensing lenses, and other optical parts.

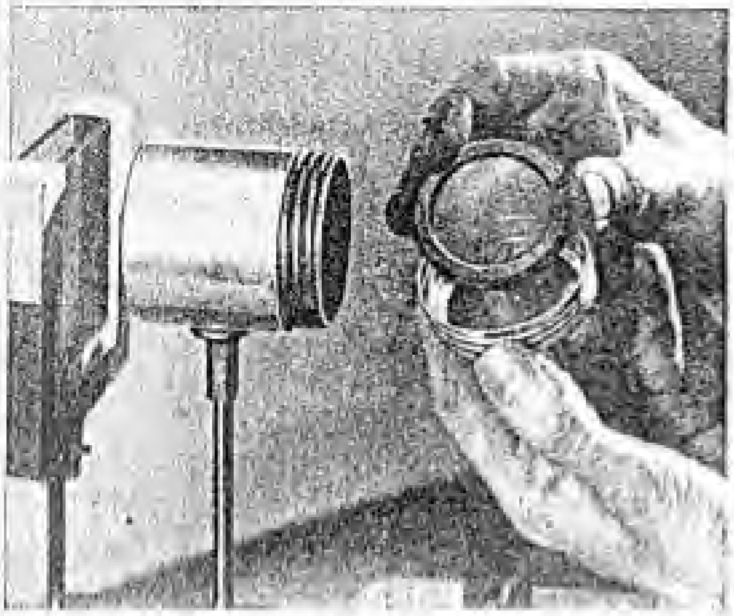
The base of the microprojector is a cast-iron lathe bed, about eighteen inches long. Such beds are used for very small wood-turning lathes, and can be purchased at hardware stores and other dealers handling home-workshop tools, for about a dollar. The bed has a slot running for most of its length, and the top surfaces of the ways, or rails, are ground level. In selecting a base, pick out one that looks reasonably straight when you sight along its upper edges. An optional improvement is to install non-marring feet, two of which should be adjustable so the bed can be leveled on an uneven bench or other surface.

For the light source, you can use a 100-watt (or larger) projection lamp; a 108-watt, six-volt microscope illuminator lamp, or a six-volt automobile headlamp. The 108-watt lamp and automobile bulb require a transformer for operation. You can buy special transformers for the microscope lamp, but it it cheaper to employ an ordinary toy transformer of 150 watts rating, with a six-volt tap. Be sure that the wattage rating is great enough to handle the lamp, or maximum brilliancy will not be obtained.

CONSTRUCTION of the lamp support and housing is shown in the photographs and drawings. The method of mounting the upright rod is important, because it also is used for other units of the projector. This upright consists of a quarter-inch steel rod threaded at one end. A machine bolt with the head cut off will do nicely, if it is long enough. This length, incidentally, depends on the height of the optical axis of the microscope above the lathe bed. Cut a block of brass or steel measuring about one-eighth by one inch, and as long as is necessary to reach across the lathe bed. In the center, drill a hole and tap it to thread over the end of the upright. Use a washer and nut, preferably a wing nut, to fasten the upright in position. This arrangement makes longitudinal adjustment easy, and lateral adjustment is possible to the limit of the width of the slot in the lathe bed.

The lamp must be adjustable for height, and have some side-to-side movement as well, so that it can be centered with respect to the rest of the optical system. A block of brass or steel, drilled to slide freely over the upright, and provided with a wing set screw to lock it in position, supports the socket and provides these adjustments. You can purchase sockets from an automobile-accessory store. The one shown is double-ended, requiring a bayonet plug at the lower end. Find the position of the socket necessary to expose the lamp filament in the direction of the microscope; and at the rear of the socket fasten, with rivets made from brass escutcheon pins or small nails, an L-shaped piece of brass or iron, measuring in cross section perhaps one-sixteenth by three-eights of an inch. In the projecting part of this piece, drill a hole to receive the screw that clamps it to the adjustable block. If you are employing a 110-volt lamp, insulate the lamp socket from the rest of the projector by using mica washers and an insulating bushing between the socket bracket and the mounting screw as shown in the drawings.

The lamp housing can be made of any kind of metal, and can be of any shape that will provide sufficient shielding, yet allow adequate ventilation. The housing shown was made from two tin cans; one, larger than the other, serves



A holder for the polarizer disk, improvised from a cardboard box with a screw lid. This disk is placed between the water cell and the end of the microscope

The analyzer disk is mounted over the microscope eyepiece in a holder made from a threaded jar lid and wire clip

How the microscope is clamped in position. Its base rests on a platform of sheet aluminum

as a cap. A short length of brass tubing, silver-soldered and riveted to the inside of the housing where it will slide over the end of the upright rod when the housing is in position, provides a support. Cut a small hole in the housing so that light from the filament can reach the condensing lenses. The smaller the hole, the better, provided it does not shield the filament.

THE proper condensing system to use for microprojection depends largely on the degree of magnification. For low-power projection without an eyepiece, and for low powers with an eyepiece, a simple condensing system consisting of a pair of plano-convex lenses, or merely a single spherical condenser lens, can be used. For higher powers, a microscope having a substage condenser should be used; or else an additional condensing lens can be placed very close to the microscope stage. A 7.5-power tripod magnifier lens, or a similar lens from a dissecting microscope, sometimes makes an excellent auxiliary condenser.

For simple projection at low or moderate magnifications, without an eyepiece or with one of moderate power, a pair of plano-convex condensing lenses like the ones illustrated will prove satisfactory. These are sixty-millimeter-diameter lenses of three-inch focus and cost, complete with mount, less than four dollars.

The photographs show these condensers mounted on an upright in such a way that they can be adjusted horizontally and vertically. It was found, however, that only the vertical adjustment is required, provided the lenses are fairly well centered with respect to the bed. Any slight variations can be overcome by adjusting the lamp position. The metal tube in which the lenses are mounted is encircled by a band of sheet brass or tin plate, which in turn is fastened to a brass block, equipped with a set screw, like that employed for the lamp socket. This brass block can be merely a piece of three-quarter-inch rod about one inch long, suitably drilled and tapped.

A WATER cell for absorbing radiant heat is desirable when slides likely to be damaged by heat, or live specimens that would be killed by it, are being projected. An easy way of making a cell is shown. Cut two squares of glass, preferably thin plate, and measuring three and a half to four inches on an edge. These pieces press against a U-shaped length of rubber tubing that provides a water-tight seal and at the same time acts as a spacer. To prevent complete collapse of this tube, insert a length of insulated electric cable or wire, or other material. Squeeze the glass tightly against the tube with C clamps and bind the edges securely with adhesive tape. Then you can remove the clamps, and the tape will hold the glass in contact with the rubber. A more satisfactory, but not so simple, method is to construct a pair of wood or metal frames and provide them with bolts and wing nuts so that pressure can be applied to the glass.

The ideal place for a water cell is between the two condenser lenses where the light travels in parallel rays; but the cell works satisfactorily enough when placed between the condensers and the microscope.

For short-range microprojection, say over a distance of five or six feet—adequate for showing slides to a dozen or so persons—you can use polarizing disks. This opens up an extensive additional field, for you can demonstrate with striking effect the remarkable range of colors and patterns produced by chemical crystals and other substances when viewed by polarized light. The polarizing disks, which can be obtained in various forms, are used in pairs, one (the analyzer) over the microscope eyepiece and the other (the polarizer) somewhere in the light beam. The disks illustrated are about two inches in diameter, and were not intended primarily for use with a microscope. It is possible to purchase disk polarizers that drop into the filter rings of standard microscopes, and analyzers that fit over the eyepieces.

THE mountings shown were designed to adapt the large disks to the projector. The one, holding the disk that polarizes the light before it enters the microscope, is made from a screw-cap cardboard container of the type commonly used for packing small machine parts, medicines, and other commodities. A hole is cut in the cap, which then becomes a threaded ring to clamp the disk against the end of the box. The bottom is cut off and the box slipped into a sheet-metal ring fastened to an upright clamped to the lathe bed. This ring fits loosely, so that the disk can be rotated to regulate the plane of polarization and to aid in producing color changes and other effects.

The analyzer disk is held over the eyepiece by another box or jar lid with a hole in it to accommodate the eyepiece. A simple wire clip, bent as shown, holds the disk in the lid, yet does not obstruct the light rays.

THE method of mounting the microscope on the lathe bed will vary with the type of base the instrument has. Generally, a rectangular piece of wood or metal can be bolted to the bed, and provided with a wood or metal bar that can be clamped, with a small bolt equipped with a wing nut, across the feet of the instrument. Be sure to adjust the microscope carefully, so that its optical axis is parallel to the lathe-bed base.

After the microprojector is complete, set it up in a darkened room, adjust the microscope for its lowest power, and clamp a slide against the stage. Move the lamp or the condenser one way or the other, until the image of the filament is formed on the plane of the slide. Focus the microscope until the image is sharp on a screen placed two feet or so away. The illumination probably will still be uneven and poor, but this is remedied by slight readjustment of the condenser or the lamp. Strive for maximum brilliancy of illumination on the screen. To achieve this requires a little patience. Finally, clamp everything rigidly in place, and you will not have to bother much with adjustments after that.

You probably will discover a number of little refinements that will improve the performance of your microprojector. A shield, such as a large disk of cardboard with a hole in it, placed around the microscope tube, will keep stray light from reaching the screen and dimming the image. If you use a microscope having a substage condenser, try the effect of removing the condenser

entirely, or of using only the lower lens of it. If your instrument has no substage condenser, try inserting additional condensing lenses.

AS FOR suitable objects for projecting, they are unlimited. For entertainment purposes, live specimens such as vinegar eels, creatures found in stagnant pond water, and small insects seem to have the greatest appeal.

For polarized-light projection, try various chemical crystals. A thin layer of crystals formed by evaporating a mixture of copper sulphate and magnesium sulphate on a slide will produce a variety of color. Examine also various hairs, potato starch, and anything else that responds to polarized light. Some objects, such as starch, will not show well beyond a projection distance of a few feet, except with the most intense illumination. Another interesting polarized-light feature is the projection of strain images in celluloid or glass. Clamp a piece of metal tightly against the edge of a draughtsman's celluloid triangle, and see if the resulting strain images are intense enough to show on the screen.

A Camera for Your Microscope

THAT'S EASY TO MAKE

Build This Simple Apparatus and Keep a Photographic Record of the Interesting Things You Discover

By GAYLORD JOHNSON

POPULAR SCIENCE MONTHLY AUGUST, 1935

PART of the pleasure of owning a microscope is the thrill of showmanship.

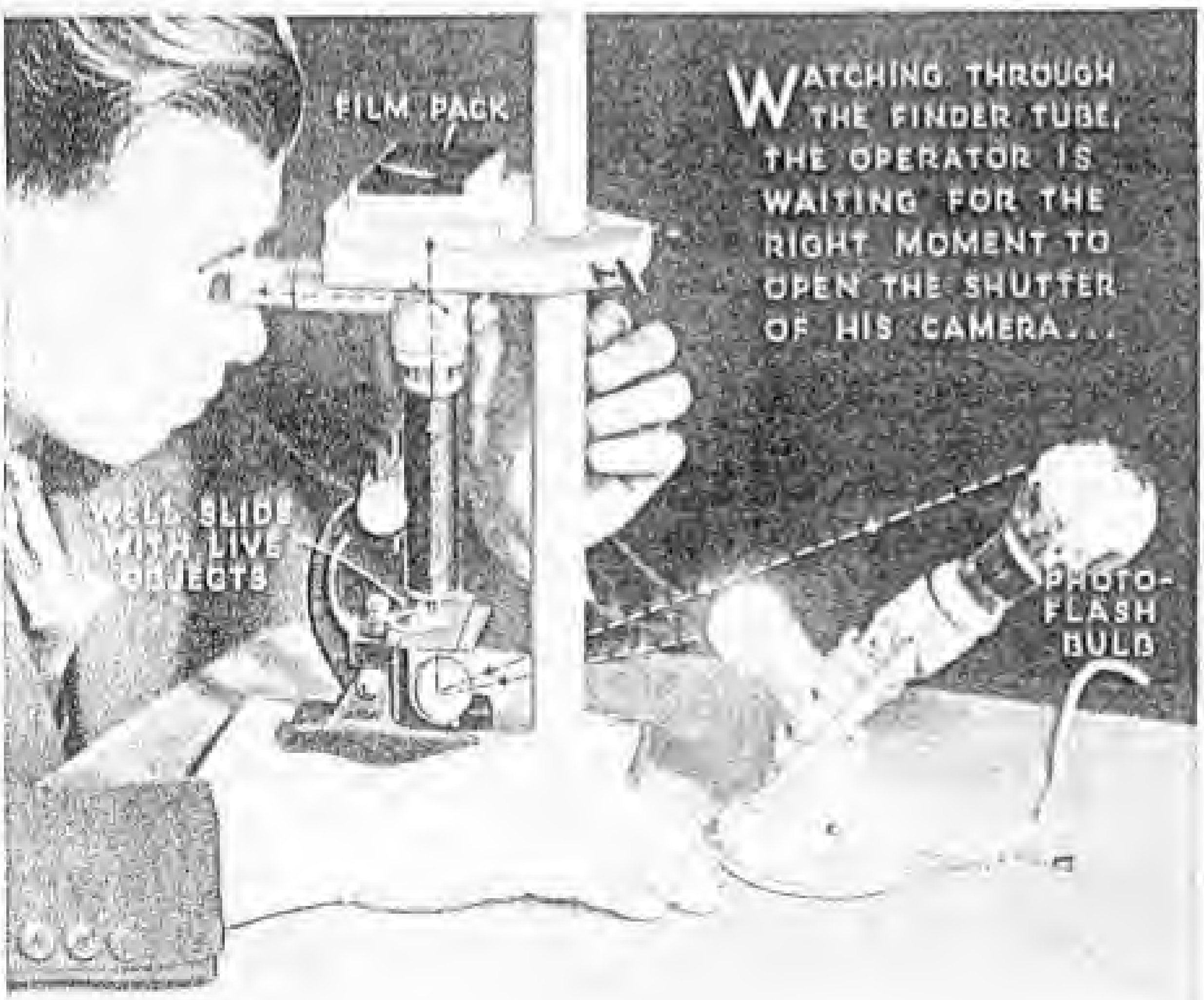
Suppose, for instance, that you are exploring the microscopic jungle of green algae in a drop of stagnant pond water, and you catch sight of a particularly interesting group of vorticellae, or bell-flower animalcules. They are as beautiful as a bed of microscopic tulips, and their movements, as they bob up and down on their springlike stems, are so interesting that you long for a friend to share the wonderful sight with you.

Such discoveries, however, are all too frequently made when the audience is absent. If you wish to exhibit them, you must resort to photography, which will fix the spectacle permanently on paper. Besides, you can in this way gradually build up an album of microscopic "animal pictures," taken in the invisible, water world which will be of increasing interest and beauty as you add to your successes in photomicrography.

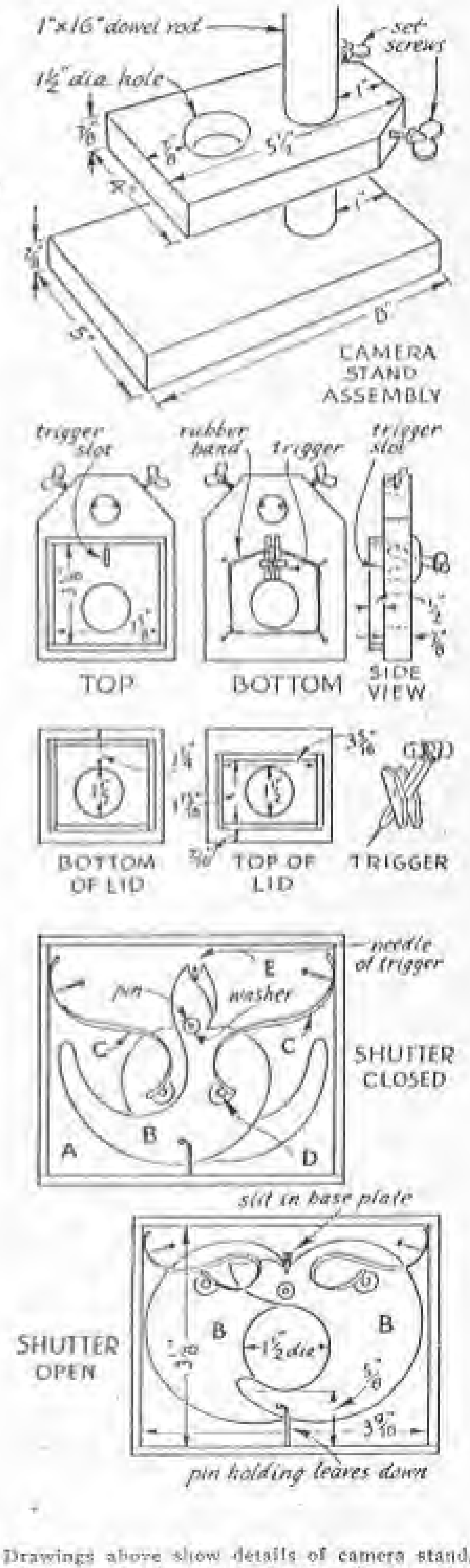
But living creatures move, and even in a drop of water they often move rapidly. How can you catch the fleeting picture—the second of relative stillness when a tiny creature is poised, perhaps, upon a green thread of microscopic plant?

To do this, you must first devise a form of camera which will enable you to observe your infinitesimal subject up to, and during, the second when the picture is taken and then provide some means of creating a flash of brilliant light with which to take the picture when the little creature is momentarily quiet.

A photoflash bulb will, of course, fur-



WATCHING THROUGH THE FINDER TUBE, THE OPERATOR IS WAITING FOR THE RIGHT MOMENT TO OPEN THE SHUTTER OF HIS CAMERA...

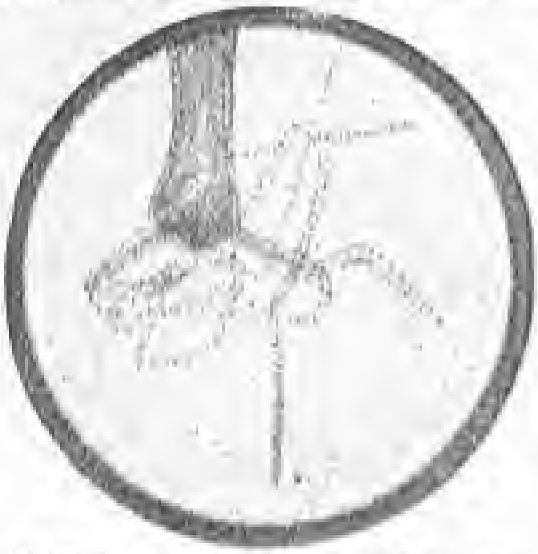


Drawings above show details of camera stand, trigger mechanism, and shutter. Patterns for shutter blades and spring are given elsewhere

nish the flash of light needed. In the case of the moving pictures, to be described later, a photoflood lamp will be used instead.

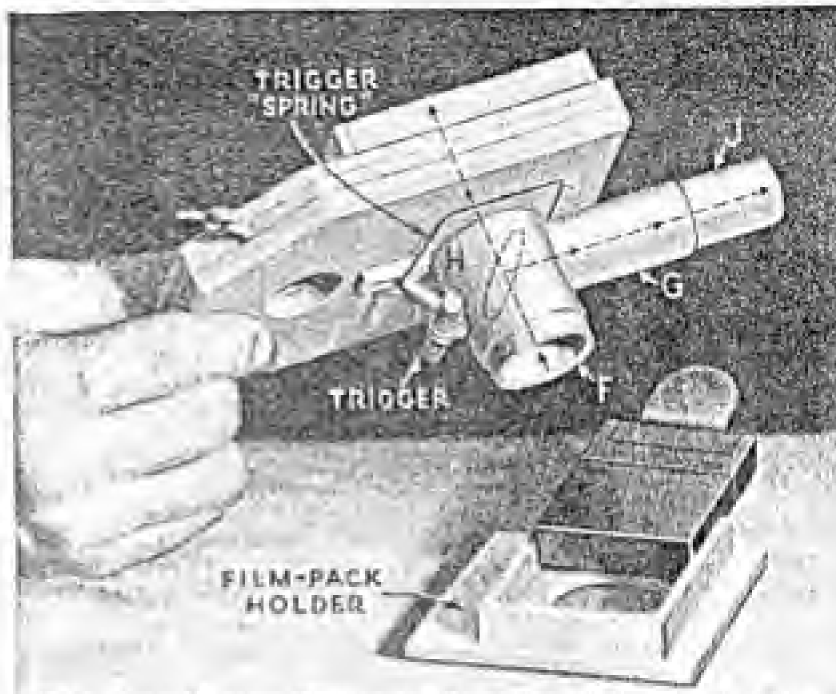
Since the essential thing you need in taking photomicrographs of living subjects is a camera of the reflex type, which permits you to view the image until the instant the picture is taken, let us see how you can construct one on a miniature scale.

This can be done easily by the use of an ordinary round, one-inch cover glass, such as is used to cover a specimen on a slide. When one of these paper-thin disks of crystal is mounted at an angle of forty-



Using the camera described here, the author made this photomicrograph of a *hydra viridis* with his own microscope

five degrees in a cardboard tube, as shown in the diagram on this page, it allows most of the light coming through the microscope eyepiece to pass straight through to a ground-glass screen on which you can view the magnified image. The cover glass is too thin to distort this image, as a thicker glass would do. Enough light, however, is reflected from the surface of the cover glass so that a part of the rays are deflected into a focusing tube (*G*), set at right angles and onto a smaller ground glass which makes a second image visible through the focusing tube (*J*). It

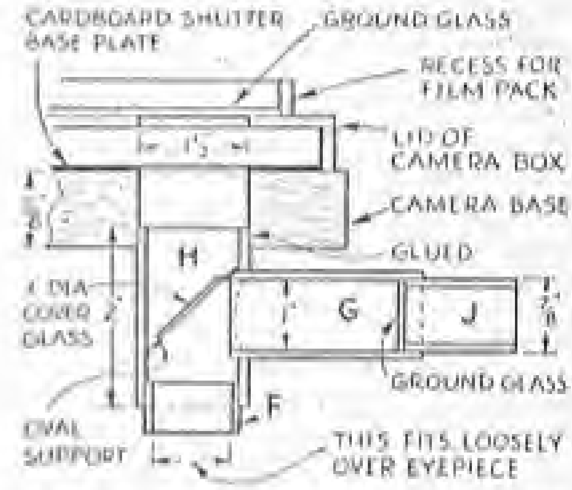


This photo-diagram illustrates the action of the slanting cover glass in allowing light from the microscope to pass through to the film pack, while also reflecting an image to the viewing tube

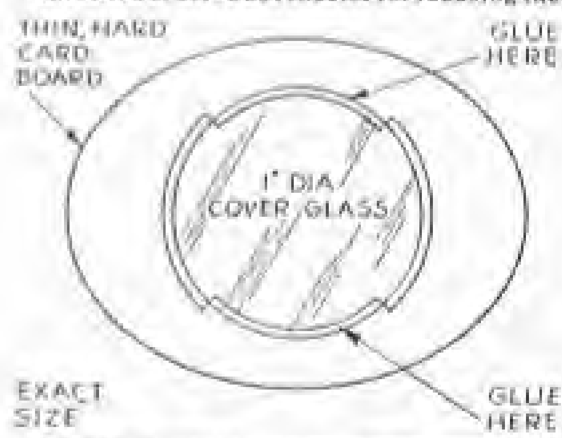
creates a sort of periscope, enabling you to see into and down the microscope tube and to view the identical image which is projected on the large ground-glass screen.

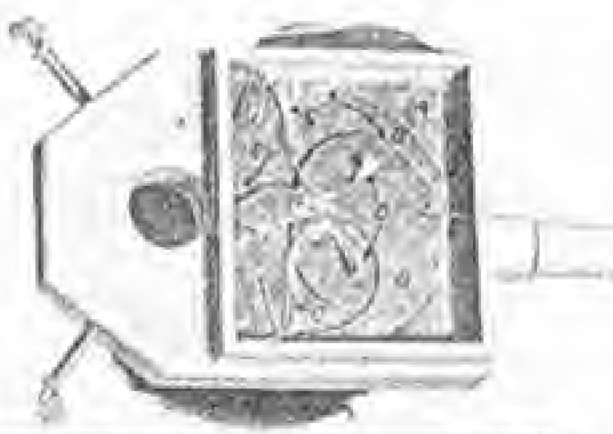
The only precaution needed in adjusting the position of the ground glass in the focusing tube is to place it so that the distance from the center of the cover-glass reflector to each of the ground-glass screens is the same.

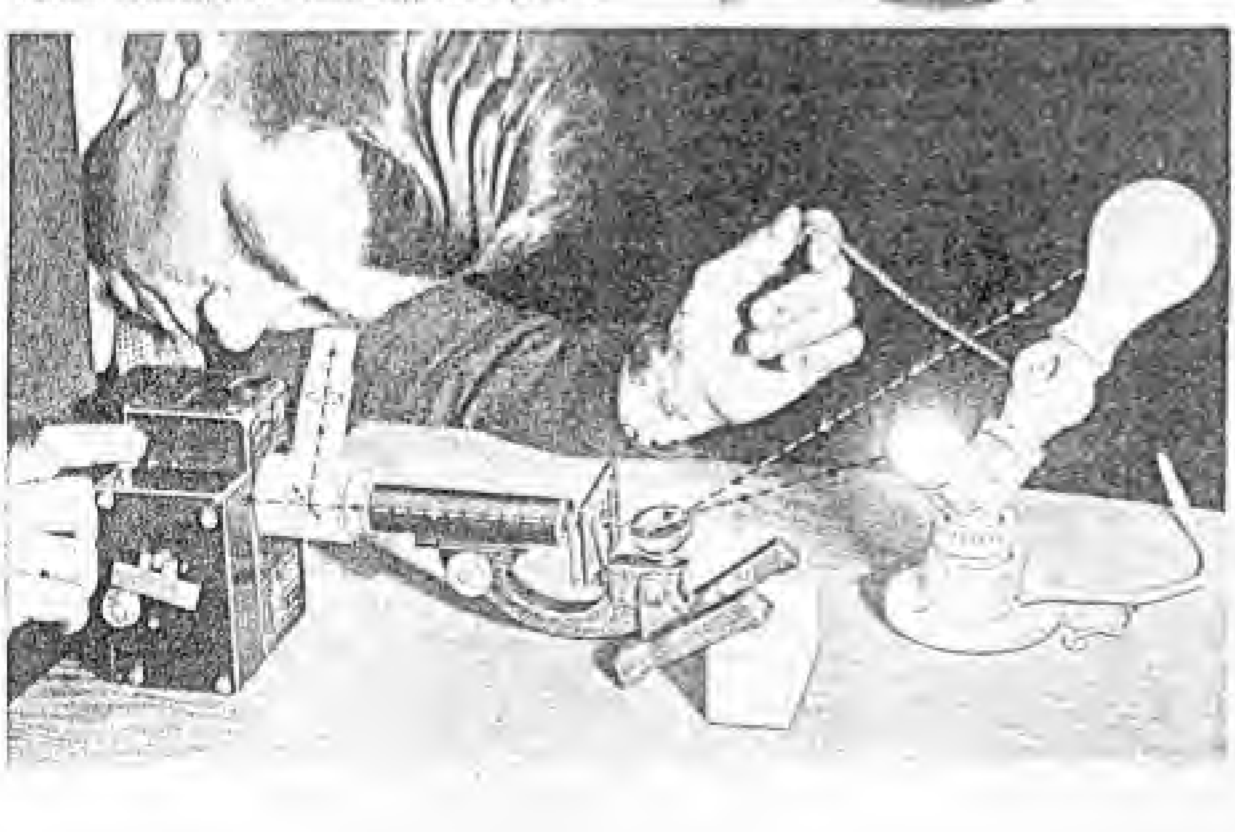
You need not, however, measure these distances. Simply mount the smaller

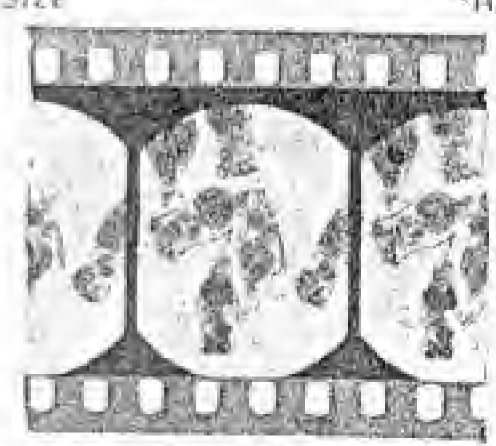


Construction of camera base and tubes. The camera base and shutter mechanism are shown at left. Below, how cover glass is mounted to serve as reflector for focusing tube









HOW MICROSCOPE MOVIES ARE MADE

With the finder tube, microscope, and lights arranged as at the left, you can take movies with an ordinary amateur movie camera, using a photoflood bulb for illumination. The film strip above was made by the author

ground-glass screen in the end of a tube *(J)* which slides inside of the main focusing tube *(G)*. Then, when the completed camera is placed on its stand over the microscope, it is easy to focus the image of an object sharply on the larger ground-glass screen and push the sliding inner tube *(J)* in or out until the image upon its ground glass is also perfectly sharp. After this focus is once determined, the inner tube can be glued firmly in place.

The tubes are easily made by moistening and rolling up ordinary gummed two-inch, package-sealing tape. The small, round screen can be cut from a sheet of the frosted celluloid sold at camera stores, from a bit of architect's tracing cloth, or a sheet of oiled writing paper. The scale plan shows the dimensions of the two tubes, which are fixed at right angles.

The next step is to construct a recess to hold an ordinary film pack of the vest-pocket size one and five eighths by two and three eighths inches, and some sort of shutter which can be opened and held open by the finger, yet will automatically close when its trigger is released.

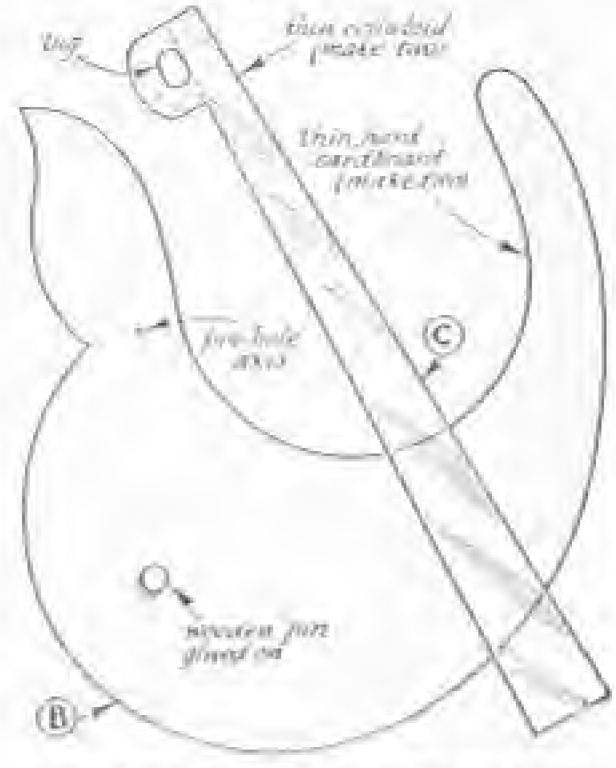
The scale plans on the opposite page, and the actual-size patterns given elsewhere will enable you to build the camera box and shutter from common materials. The base plate *(A)* and the shutter blades *(B)* should be cut from fiber cardboard having the smoothest possible surface. Such cardboard is often used for the covers of cheap note books. Printers also use it under the name of pressboard. The shutter blades and base plate can, however, be cut from playing cards with the upper surfaces blackened with waterproof India ink. An extremely smooth surface is necessary so that the shutter blades will slide on each other, and on their base plate, with a minimum of friction.

The shutter springs *(C)* are made from any convenient piece of thin sheet celluloid. I used a piece that was serving as a window in a package of large needles. The shutter pins *(D)* are simply bits of round toothpick fastened to the shutter blades with glue.

The opening movement of the shutter is caused by the crowding apart of the scissor-like blades by a strong needle *(E)* fastened into the end of the trigger lever. This happens as the trigger is pressed back, moving the needle forward. When the trigger is released, the trigger lever is drawn forward by the rubber-band spring and the celluloid shutter springs push the shutter blades closed.

If the patterns of the shutter blades and shutter springs are carefully followed, you will have no difficulty in making a shutter which will close quickly and positively when released.

Now that our camera is complete, let us try it out by taking a flash-light snapshot of some little pond creature. Place two or three



Full-size patterns for the shutter blades and springs. The blades are made of smooth fiber cardboard, the springs of thin sheet celluloid

drops of pond water, with a few shreds of green algae floating in them, in a well slide on the stage of your microscope. The construction of a well slide was described in an earlier issue (P. S. M., Feb. '33, p. 16).

THE light sources should be arranged as shown in the photograph. The pull switch (screwed into one side of a double socket) is off and a photoflash bulb is screwed into its socket. Light the small ten- or fifteen-watt bulb in the other side of the double socket so that its rays are thrown up through the microscope by the mirror.

After locating a field containing some promising creature—vorticella, rotifer, or what not—focus the image carefully on the ground glass and replace the glass with a film pack. With the shutter of the camera closed, pull off the pack's safety cover.

All is ready for the exposure except the subject. With your eye to the viewing tube, manipulate the focusing screw of the microscope to keep your subject in focus. If it suddenly leaves the field, shift the slide on the stage a little and follow it, if possible. Or find another subject. When it is finally quiet and in focus, quickly, but gently, open the shutter trigger with your left hand and turn the current into the photoflash bulb with your right. Then instantly release the shutter trigger and allow it to close the blades.

IF YOU find a subject which is firmly attached to a filament of algae (and relatively quiet) you need use only a ten-watt frosted bulb instead of the photoflash, making a quick time exposure by pressing back and releasing the shutter trigger. A fifth to a half second is enough. You will find it better to stick to the lower powers of your instrument at first (100 diameters or less) as the amount of light coming through to the film is weakened considerably by using the higher-powered objectives.

Probably one of the most fascinating photographic stunts to be done with a microscope is the taking of movies. For this, you must have some kind of motion-picture camera. This is not, however, an adventure to be undertaken until you have mastered the technique of taking "stills" as just described. After you have had some good results with this photoflood or flash method, you can advance confidently into the movie field.

The strip of film reproduced was taken by the author with an old-fashioned hand movie camera (using standard thirty-five-millimeter film) but it could have been done equally well with sixteen-millimeter equipment. It is not, however, advisable to experiment with eight-millimeter cameras. The adjustments are too small.

The technique differs from that of "stills" only in that you cannot focus on a ground glass placed in the plane of the film but must measure the distance between the film plane and the camera front, after removing the lens. With this measurement, you can arrange your focusing attachment so that your first experimental shot flashes will be fairly sharp. After taking them, mark with a pencil the point on the inner tube *(J)* to which it is pushed in.

To increase the sharpness of your pictures, the following steps should be followed: Put any mounted specimen slide under the objective. Adjust the camera with the lens tube *(H)* pushed all the way into the empty lens socket. Focus on the screen at a point where you tried the first experimental flashes. Pull out the focusing tube *(J)* slightly and refocus. Turn on the flood light and take a one-second flash. Mark the point on the tube *(J)*. Then push the tube in very slightly beyond the mark where the original flashes were tried, and take another short flash. Also mark this on the tube. When the roll of film with these experiments on it is developed, you can determine at which of the three experimental points the tube *(J)* should be permanently glued into a fixed focus.

AS IN every other phase of craftsmanship, perfection comes only to the persistent. At first, your hunting of live creatures in the microscopic jungle may include more misses than hits, but even then you often will be rewarded by some beautiful snapshot—perfectly caught and in focus. As you become more and more at home with your equipment, your average will get better and better, until you have the satisfying album of enlargements from your negatives which is the goal of every photomicrographer. And when you give a little show of microscope movies, you can be sure that your audience will be thrilled.

Continued from page 2612

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Continued on page 2640

Hook a CAMERA to Your MICROSCOPE

WITH HOMEMADE APPARATUS COSTING ONLY A FEW DOLLARS TO BUILD, YOU CAN RECORD YOUR DISCOVERIES IN PHOTOMICROGRAPHS

By MORTON C. WALLING

POPULAR SCIENCE MONTHLY JANUARY, 1938

IT'S a lot of fun looking at things through your microscope. You won't argue about that, after having explored the mysteries of pond water, bits of hair, and the thousand and one other things there are to examine. But merely looking is only half the fun. Equally fascinating is the business of recording your discoveries on photographic film.

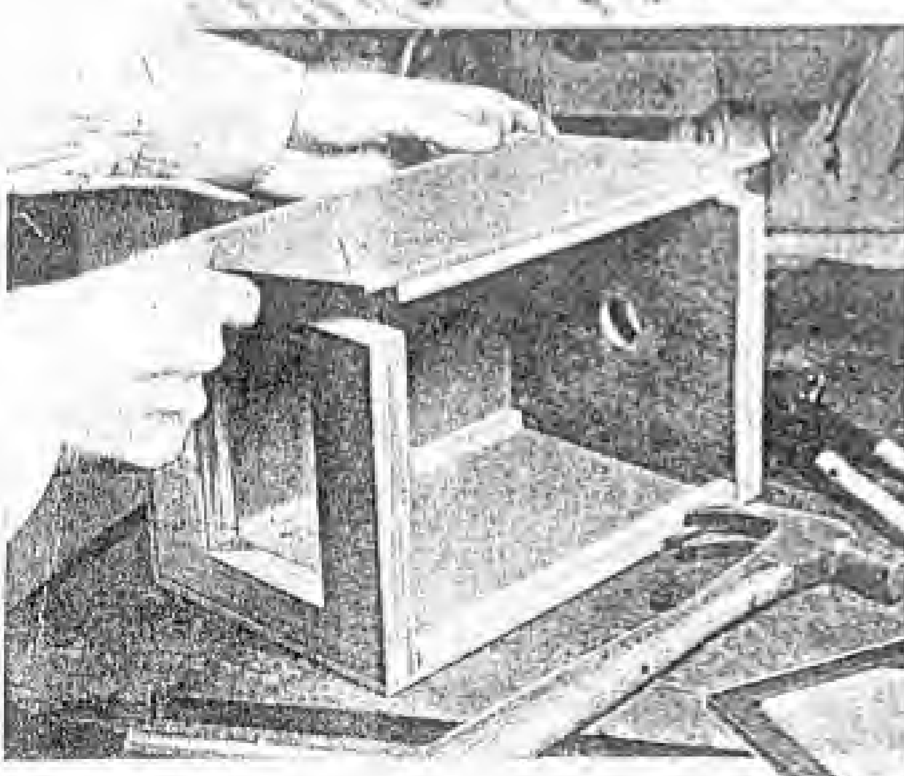
Don't let the term "photomicrography" scare you, for it actually is no more difficult to make a good photomicrograph of a bee's knee than it is to make a good snapshot of your Uncle John. All you need is your microscope and a little additional equipment, most of which you can make yourself.

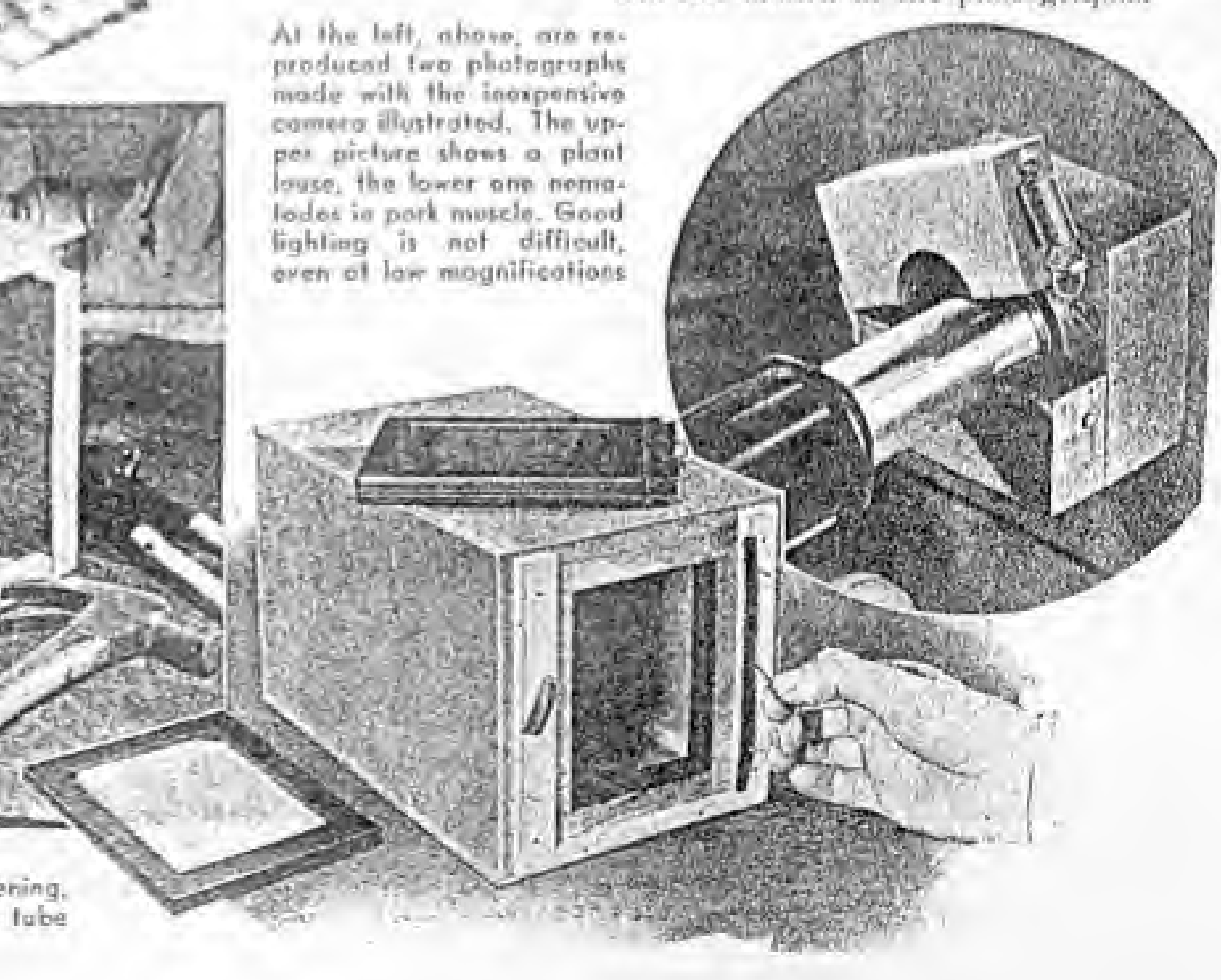
In addition to your microscope, you must have a source of light, a piece of photographic film, and some arrangement for holding the film so that only light passing through the microscope strikes it. Some way of focusing the image sharply on the film also is necessary.

Maybe this sounds too simple. But not long ago I visited a young chemist who, with no more equipment than this, was turning out photographs of microscopic subjects that would make a professional photomicrographer with a room full of equipment sit up and stare. His camera was made from a store box, and you still could see the marks of the saw that ripped the boards. He apparently was violating or ignoring a lot of so-called rules; but he was getting pictures—mainly because he had learned, by trial and error, just how to handle the equipment he had.

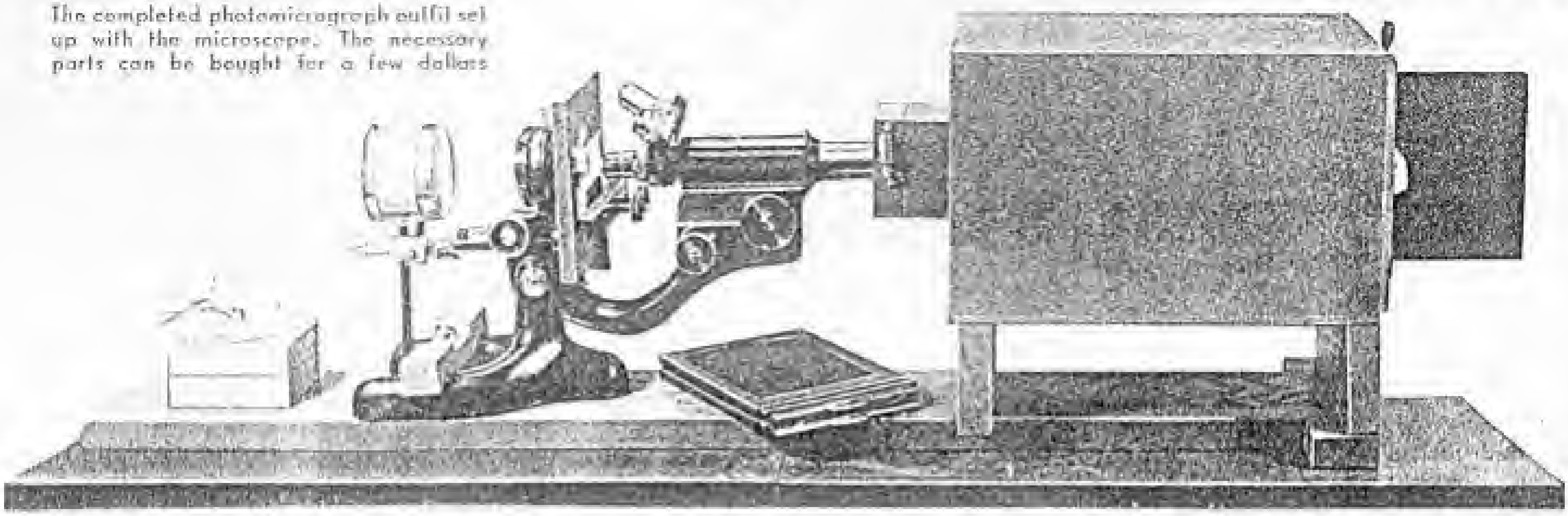
The first thing is to make the camera. This consists of a light-tight wooden box, shaped somewhat like a shoe box, mounted in a horizontal position on a wooden base. The box can be made of any material that is rigid but not too heavy, such as quarter-inch lumber from a store box, or one of the composition panel materials. Dimensions are not very important, but, as a suggestion, the box can measure ten inches long by six inches square, like the one shown in the photographs.

At the left, above, are reproduced two photographs made with the inexpensive camera illustrated. The upper picture shows a plant louse, the lower one nematodes in pork muscle. Good lighting is not difficult, even at low magnifications





Construction details of the camera box, film opening, and split-block coupling to take the microscope tube



The completed photomicrograph outfit set up with the microscope. The necessary parts can be bought for a few dollars

Against one end of the box rests the eyepiece of the microscope, which has been broken over to a horizontal position. If your instrument doesn't have such an adjustment, mount it on a support that will hold it horizontal. Either the microscope or the box is blocked up, so that the two are centered with respect to each other.

There are various ways of coupling the microscope so that no stray light will leak into the camera around the end of the tube. One simple method is to make a little tube of black cloth, preferably several layers of it, and provide one end with a draw string, a coil spring, or a rubber band sewed into the seam. This fits around the microscope tube. The other end is tacked over a one-inch hole bored in the box end. Another method, which permits the microscope to be removed easily for visual observation, is illustrated. A split block having a hole large enough to fit around the microscope tube is fastened to the box end. One half of the block is hinged to permit it to swing upward, releasing the microscope so that it can be removed or tilted to an upright position for visual observation.

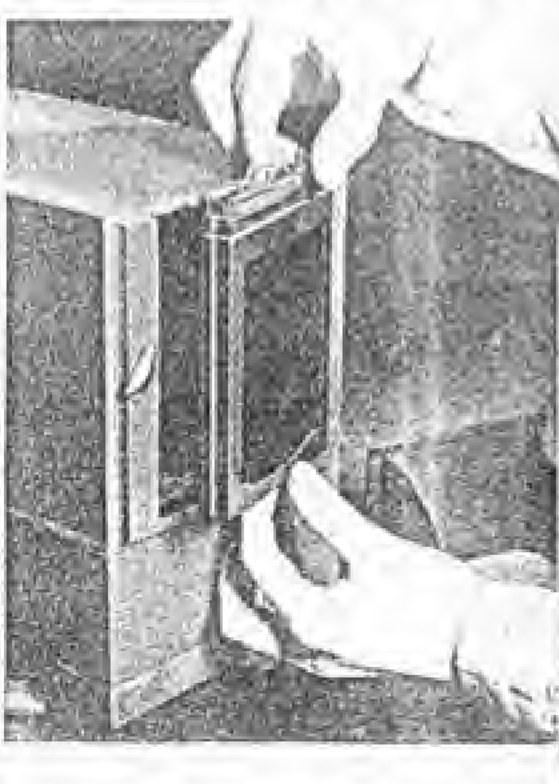
In the other end of the box, cut an opening for the film or plate. A convenient size film is 3¼ by 4¼-inch. Although it is possible to make cut-film holders or film-pack adapters from metal or wood, you will save yourself a lot of trouble by purchasing them already made. Frequently you can get good used ones at a photographic shop.

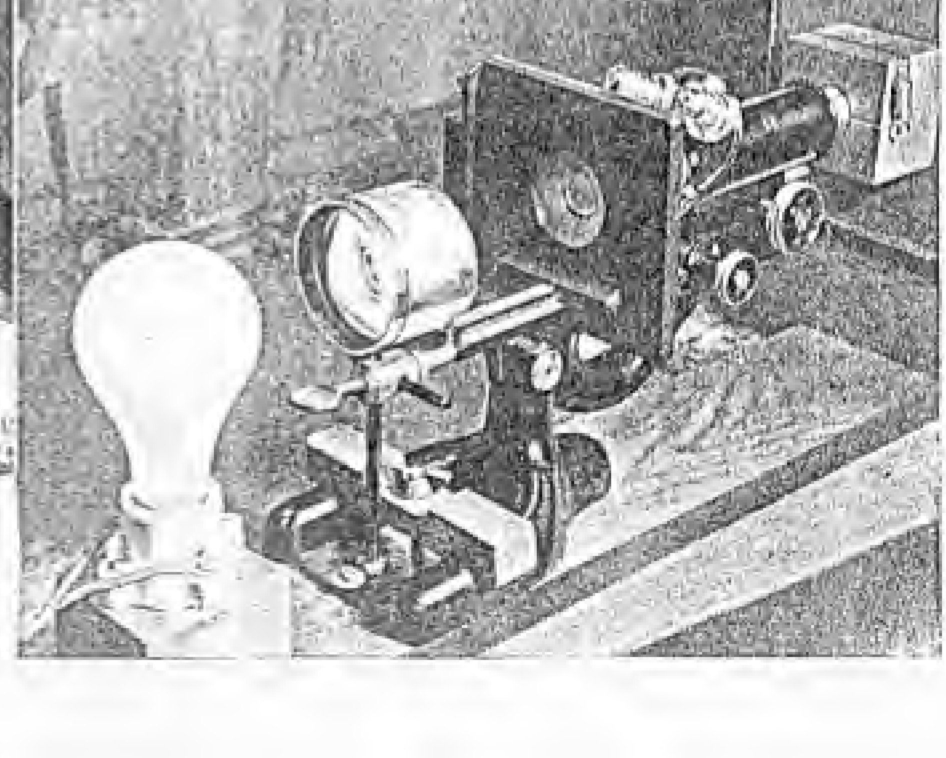
After deciding on a film size, cut an opening in the end of the box slightly smaller—say an eighth of an inch all around—than the film dimensions. On the outside, around this opening, mount strips or other devices for fastening the focusing screen and film holders in place. The illustrations show the arrangement for holders which have grooved edges. The focusnig screen can be simply a piece of ground glass mounted in a wooden frame in such a way that the distance from the ground surface of the glass to the microscope-eyepiece opening or any other fixed point of the camera is exactly the same as the distance from the film surface to the same point when the film holder is substituted for the focusing screen.

Fasten the base of the microscope firmly to the base of the camera, so that the tube will be held rigidly in position. Adjust it so that the tube is exactly perpendicular to the film surface, and directly opposite the film center. A cross bar held by a bolt and winged nut anchors the microscope base, as shown.

Paint the inside of the box and all parts of the film-holding equipment a dull black. You can make a suitable paint by mixing powdered lampblack or drop black with shellac or lacquer. The proportion of pigment to vehicle should be such that the surface is completely free from sheen when dry.

Now, with this and nothing more, you can make photomicrographs, using daylight (not direct sunlight) for illumination. Clamp a slide to the microscope stage, insert the focusing screen in the back of the camera, and adjust the substage mirror of the microscope until an image is visible on the ground glass. Probably the brilliancy of this image will not be very great, even at low magnifications. Now focus the microscope as sharply as you can, using a small hand magnifier, if necessary, to examine the image on the





How a plate holder is fitted into the place provided for it. Right, the illumination system, consisting of the photoflood lamp with a condenser

ground glass. Remove the glass and substitute a film holder for it. Stick a piece of cardboard between the substage mirror and the light source, to keep light out of the camera, and pull the slide out of the film holder. Now, using the cardboard as a crude shutter, make the exposure. As for the length of the exposure, you'll have to determine that by experiment, or else be lucky at guessing. As a start, try five seconds at a magnification of 100 diameters.

ALTHOUGH you can use daylight for such work, it is a lot more convenient to employ a high-intensity source of artificial illumination. Photoflood lamps, intended primarily for general photographic work, offer a simple way of doing this. You can mount one of these lamps about six inches from the substage mirror or, if directly in line with the objective so that no mirror is necessary, about the same distance from the slide, and use it without any auxiliary equipment. But you are likely to find that the illumination is rather poor, if your microscope does not have a substage condenser. It is of considerable advantage to interpose a condensing lens or pair of them between the lamp and slide. A pair of sixty-millimeter-diameter (2 2/5-inch) plano-convex condensing lenses like those mentioned in connection with the microprojector (P.S.M., Sept. 1937, p. 76) will do nicely. Place the pair (which should be purchased in a mount rather than unmounted) so that one of them is about two inches from the surface of the photoflood lamp, and the other is four or five inches from the slide. The exact distances for best illumination are found easily by experiment. Lamp and condenser should preferably be mounted on an extension of the camera base, as illustrated.

IT IS not necessary to provide a housing for the photoflood lamp, but it may be desirable to arrange some kind of a shield that will keep its rays from striking your eyes directly. If you do make a housing for it, out of a length of stovepipe or other material, be sure to provide plenty of ventilation, and to use a socket not easily damaged by heat.

Doubtless you are worrying about the kind of film to use for photomicrography. In the final analysis, it will depend to some extent on the kind of work you are doing. But, generally speaking, you will find it advantageous to use a fairly contrasty panchromatic film (or plate). Panchromatic film is sensitive to all colors of the spectrum.

For work not involving red light, you may find an orthochromatic film, or even "color-blind" film sensitive mainly to blue light, equally good or better. There are on the market special fine-grained panchromatic films, which can be obtained in roll, pack, or cut form.

This is a small photomicrograph outfit of the type that is commonly sold for use with inexpensive amateur microscopes

These generally are suited to photomicrography because of their high contrast. Another good film, where extreme contrast is desired, is process panchromatic. Among the materials made specially for photomicrography are Wratten M. and Wratten metallographic plates. The M plates are sensitive to all colors of light, while the metallographic plates are not sensitive to red.

IF YOU do your own developing, it is best to use developing and fixing formulas recommended by the makers of the film or plate you are using. Make your prints like you would any other photograph, either by contact printing or projection.

And that's all there is to the making of pictures through the microscope. Fundamentally, the process is not a bit different from the making of any other kind of photograph: you merely substitute a microscope for your camera lens.

Professional types of microscopes generally are designed so that the image formed on a ground glass placed at a distance of about ten inches from the eyepiece represents a magnification identical with that observed by looking through the microscope. Therefore, if your ground glass is at that distance, the magnification can be determined directly by multiplying the power of the objective by that of the eyepiece. If you increase the distance between eyepiece and ground glass to twenty inches, the magnification (on the ground glass) will be doubled. At three times the standard distance it is trebled, and so on. However, there is a limit to how far this process can be carried, for various factors tend to fuzz up the image as the extension becomes greater.

IF YOUR microscope has a substage iris diaphragm, you will be using it to gain contrast, by reducing the size of its opening. Care must be taken not to carry this too far, or the diffraction rings and other patterns will damage or destroy the image. Excessive stopping-down is evidenced by false lines about the margins of the image, by double images, and by a general distortion of detail.

After you have mastered the fundamentals of photomicrography with an outfit like the one described, there is no limit to the extent to which you can carry the hobby. Modern natural-color films, for example, open up a vast field in the recording of stained specimens or those illuminated by polarized light.

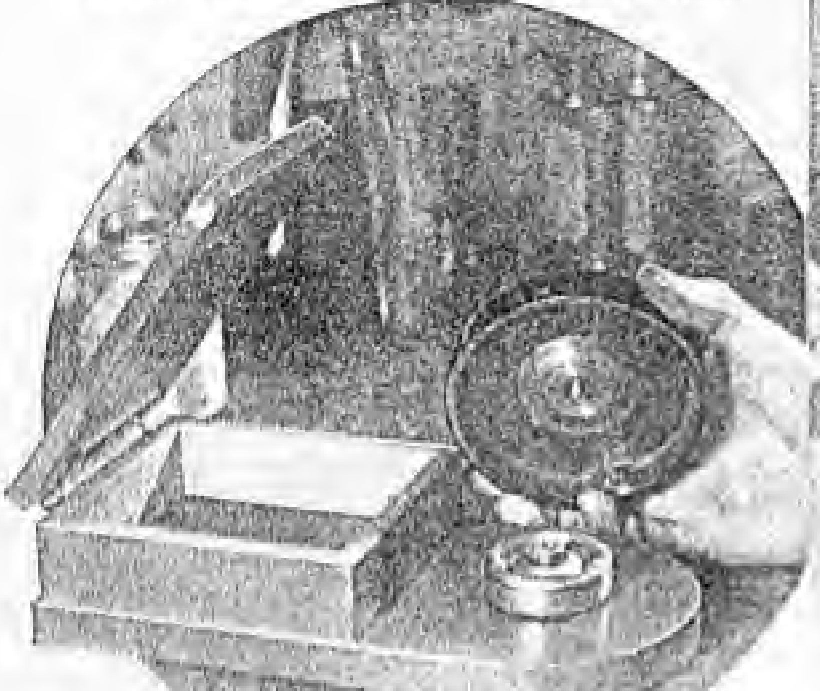
Microscope Turntable

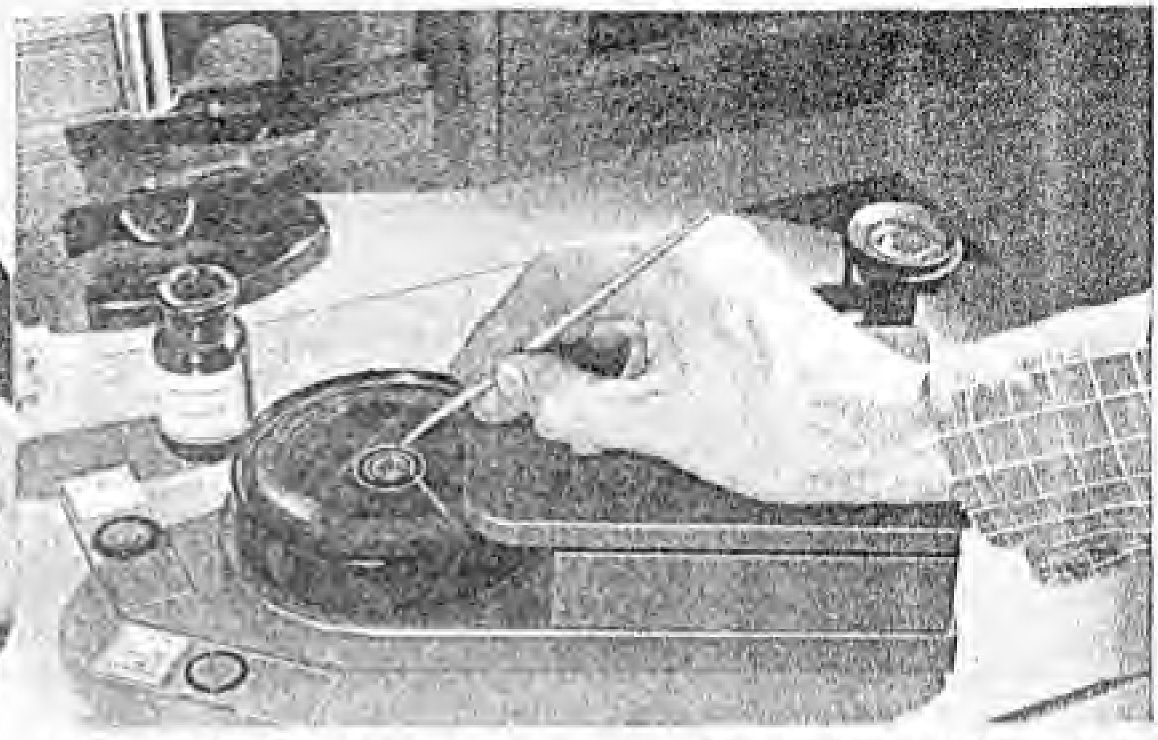
FOR MAKING SPECIMEN SLIDES

By Morton C. Walling

POPULAR SCIENCE MONTHLY
FEBRUARY, 1937

The turntable disk rests on a roller-skate wheel, as shown below. The arm rest covers a storage space





A ring of shellac being built up on a microscope slide with the aid of the turntable. The disk is spun by hand, and shellac is applied with a small, artist's painting brush

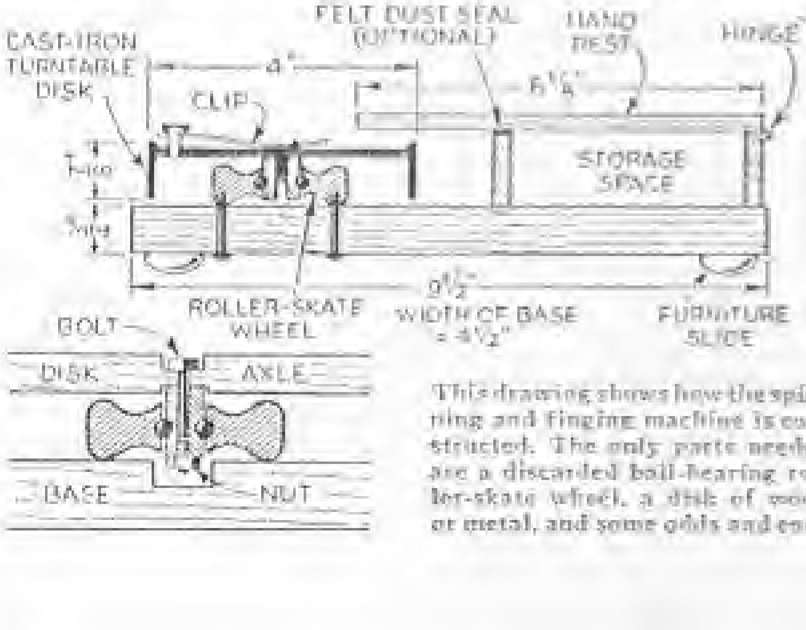
FEW pieces of auxiliary equipment will prove more valuable to you in your work with a microscope than a well-made turntable or "spinning wheel." With it you can quickly build up rings of shellac on microscope slides to provide cells for large specimens, or apply the circular seal of cement to hold a cover glass in place.

The usual type of spinning machine consists simply of a base on which is mounted a rotable circular disk, or wheel, and a convenient hand rest. The top of the disk is provided with spring clips for holding a specimen slide. To make a cell, the operator clips a slide to the turntable, centering it accurately; dips a small, round, artist's brush in fairly thick shellac, gives the table a spin, and holds the brush tip so that it traces a ring on the rotating slide. Successive applications of shellac build the ring to any desired height. In a similar way, the turntable is used to produce neat rings around the edges of circular cover glasses, with asphalt varnish, shellac, or other sealing material.

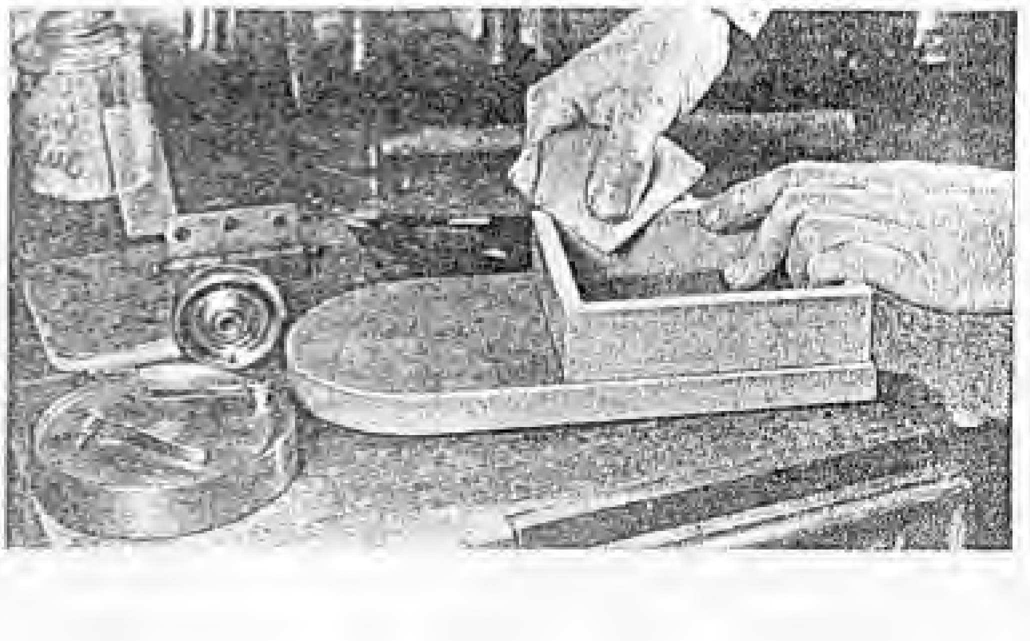
Although a variety of commercial turntables are available, the amateur microscopist can provide his home laboratory with a really professional model from a few odds and ends of wood and an ordinary ball-bearing, roller-skate wheel. First cut a base piece to the dimensions indicated in the drawings (a size to take a four-inch disk), and mount the skate wheel as shown. There are several ways of doing this. In the model illustrated, the wheel was drilled and tapped to receive two 6-32 machine screws that pass through the base piece. If the wheel axle does not clear the base piece when the wheel is resting on its side, a depression should be cut beneath it. The axle must rotate freely.

The turntable disk shown is made of cast iron, with a brass center pin that enters the quarter-inch hole in the skate-wheel axle. However, the disk can be made equally well of wood or plywood one-half to three-quarters of an inch thick. The disk should run as true as it is possible to make it. If feasible, a lathe should be used in shaping it. On the top surface of the disk, mark the exact center, and several concentric rings about one-eighth of an inch apart, so that the slide can be centered easily. You can do this after the disk is in place. The clips used to hold the slide in place on the disk are similar to those used on microscope stages. They can be simple strips of springy metal or, as shown in the photograph, a pair of clips from the stage of a professional-type microscope.

The hand rest is a piece of plywood one quarter or three eighths of an inch thick, extending about halfway to the center of the disk. It must be supported high enough above the base piece to clear the clips. In the model shown, this support consists of a boxlike frame, made of 1/4 by 1 1/4-inch wood strips. The hand rest is hinged to the edge of the frame opposite the disk, thus forming a lid for a compartment in which spare slides, containers of shellac, and other supplies can be kept.



This drawing shows how the spinning and ringing machine is constructed. The only parts needed are a discarded ball-bearing roller-skate wheel, a disk of wood or metal, and some odds and ends



A Portable Kit *for your* MICROSCOPE

By Morton C. Walling

POPULAR SCIENCE MONTHLY JANUARY, 19[illegible]

A PORTABLE kit that holds your microscope, various bottles, instruments, illuminator, microtome, specimen boxes, and slides will enable you to take your hobby with you wherever you go. You can use the kit on your desk, workbench, or the kitchen table; and it affords a convenient place to store your equipment when not in use.

Being designed to hold a full-sized microscope and accessories, the kit is somewhat larger than would be necessary if the small microscope seen in the photographs were to be used with it exclusively. Also, the size was determined somewhat by the dimensions of the laboratory table to which it is [illegible].

There is nothing difficult about making the outer case because in reality it is a plain box with a removable door in front. It can be made of whatever wood is available. If the parts are carefully squared, the joints well fitted, and glue is used as well as nails and screws, the case will be both strong and neat. Where a small circular saw is available, however, the case can be made with rabbeted joints as shown in the accompanying illustrations. In the original model, five-ply maple veneer paneling [illegible]-in. thick was selected for the outer case and [illegible]-in. thick three-ply veneer for the drawer case. White pine [illegible]-in. thick was used for all parts of the drawers except the sidepieces of the slide-filing drawer, which are ⅝-in. thick. If solid wood is used for the outer case, it should be [illegible]-in. thick.

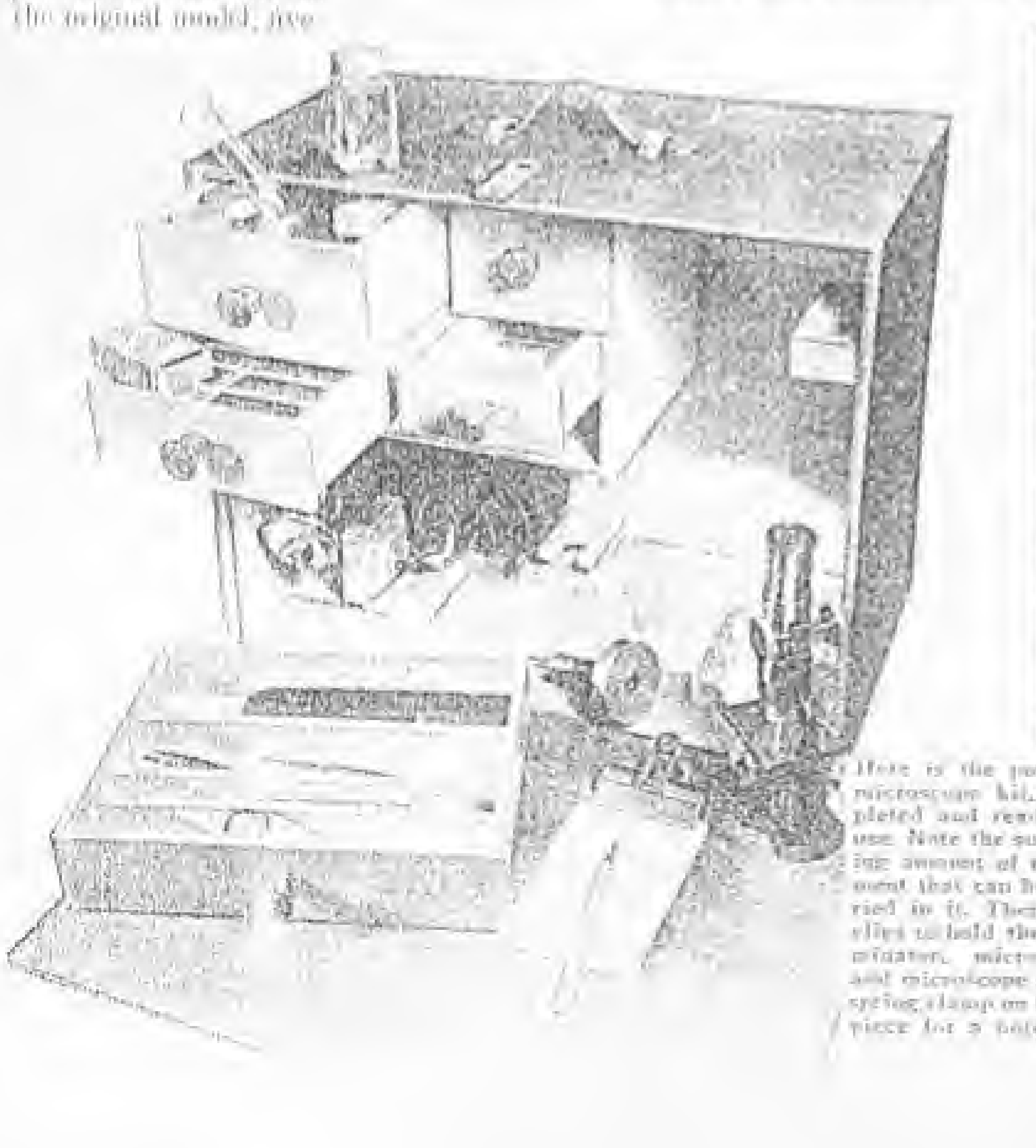
The case is 17[illegible]-in. long, 14-in. high, and [illegible]-in. deep, outside dimensions. If [illegible]-in. thick veneer paneling is used, make the end pieces 9[illegible]-in. by 14-in. and cut rabbets [illegible]-in. deep by [illegible]-in. wide around all four edges of each on the inside surfaces. The top and bottom will be 9½-in. by 17½-in., and should be rabbeted along both of the longer edges, on the inside surfaces. The back and front are 13⅝-in. by 17⅛-in. so as to fit in the rabbets. The edges of the front board should be dressed so that it will slip in easily but snugly; the back, however, should fit reasonably tight. Fasten the ends, top, bottom, and back together with glue and brads or slender round-headed screws.

Four brass box corners are mounted on the lower four corners of the case. These in front form pockets into which the two lower corners of the front board can be slipped. The upper edge is held by a hasp and staple with either a hook or a padlock, as preferred.

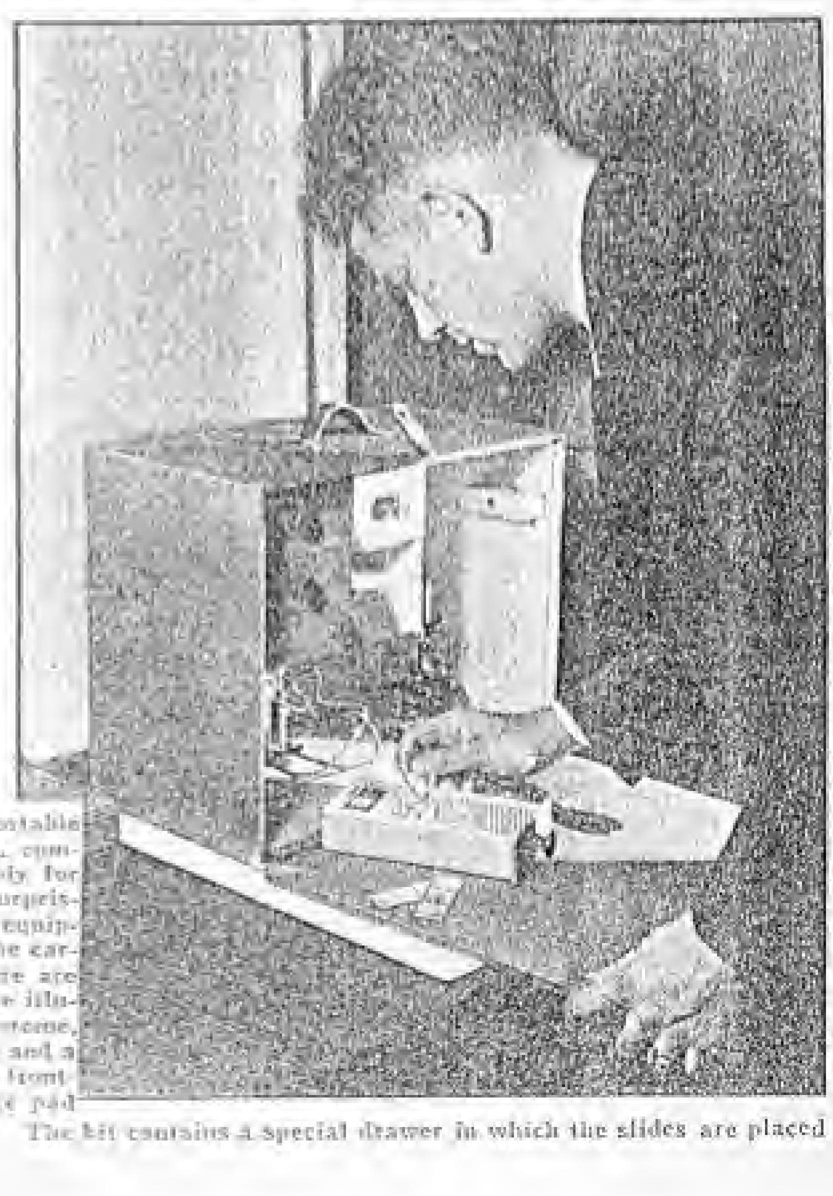
The inner case for the drawers can be made as a separate unit—that is, like a box with top, bottom, two ends, and the necessary partitions, and inserted after it has been assembled. The author, however, built the drawer case right into the larger case, as shown.

The drawers are made to fit the openings in the drawer case. The fronts, however, are a little larger than those openings because they overhang the edges of the drawer case. None of the drawer fronts, however, projects at the top in the plan given.

Some of the drawers have inside partitions. The upper left-hand drawer for test tubes has three strips running from front to back. The specimen boxes used in another drawer are empty safety-match boxes. At the rear are two compartments for miscellaneous objects. The lower drawer for instruments has three partitions, variously spaced, running across from side to side. In constructing the slide drawer, the slots in the sidepieces can be made easily on a circular saw or in

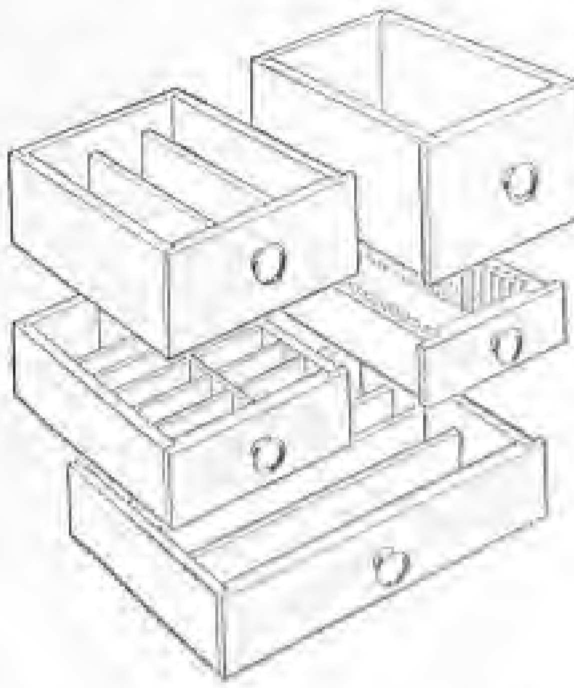


Here is the portable microscope kit, completed and ready for use. Note the surprising amount of equipment that can be carried in it. There are clips to hold the illuminator, microtome, and microscope and a spring clamp on frontpiece for a note pad

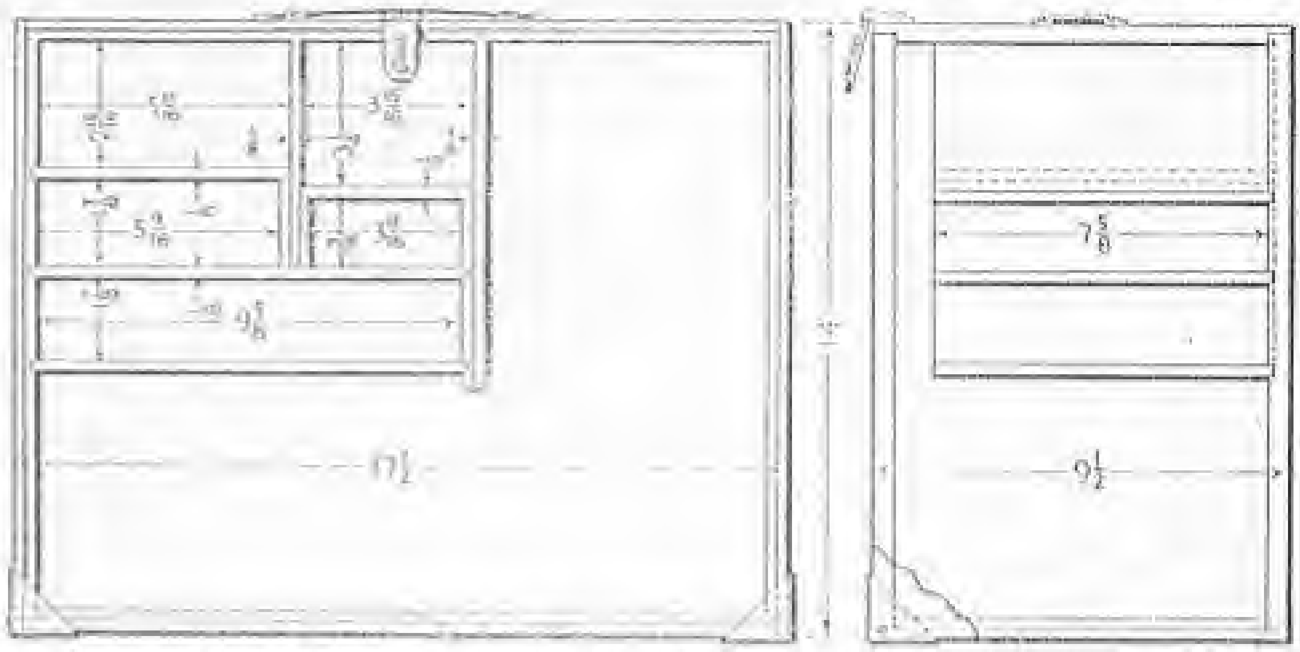


The kit contains a special drawer in which the slides are placed

a miter box having some kind of spacing arrangement. The grooves are spaced on



3/16 in. centers. The upper right-hand drawer is for miscellaneous supplies and has no partitions. If desired, two additional slide drawers can be substituted for it. In the portion of the case not occupied by the drawers are various clamps and other fittings. The eyepiece holder, fastened to the side of the box near the microscope, consists of a strip of wood having a row of holes. It is best to construct this holder so that the holes have closed bottoms, and to line them with some soft material such as felt. The exact design of all clamps will depend on the equipment itself.



Above: working diagram of microscope kit. At left, its drawers with partitions in place

The illuminator illustrated consists of a bell-ringing transformer equipped with a flashlight reflector and a No. 40 6-volt radio dial light. If you are traveling where there is no 110-volt electric supply, you can substitute a dry-cell battery for the transformer, and use a low voltage focusing-type flashlight bulb instead of the No. 40.

You will find that a spring clamp similar to those employed on clip boards, mounted on the inside of the front piece near its top and directly in front of the drawers will be handy for holding notes. The front board thus becomes a convenient drawing board.

The outside of the kit can be finished in any conventional manner, and the inside surfaces left in their natural state. A set of furniture glides on the bottom of the kit box is an improvement.

The cost of the kit illustrated, including bottles, specimen boxes, and clamp, was about four dollars, more than half of which was for the maple veneer paneling. This means that the kit can be built for as much or as little as you wish.

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Many of the microscope articles refer to other such articles in previous issues. To find these other articles quickly, refer to pages 2612, 2634 and this page.

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Secrets of Meat Curing and Sausage Making 1908

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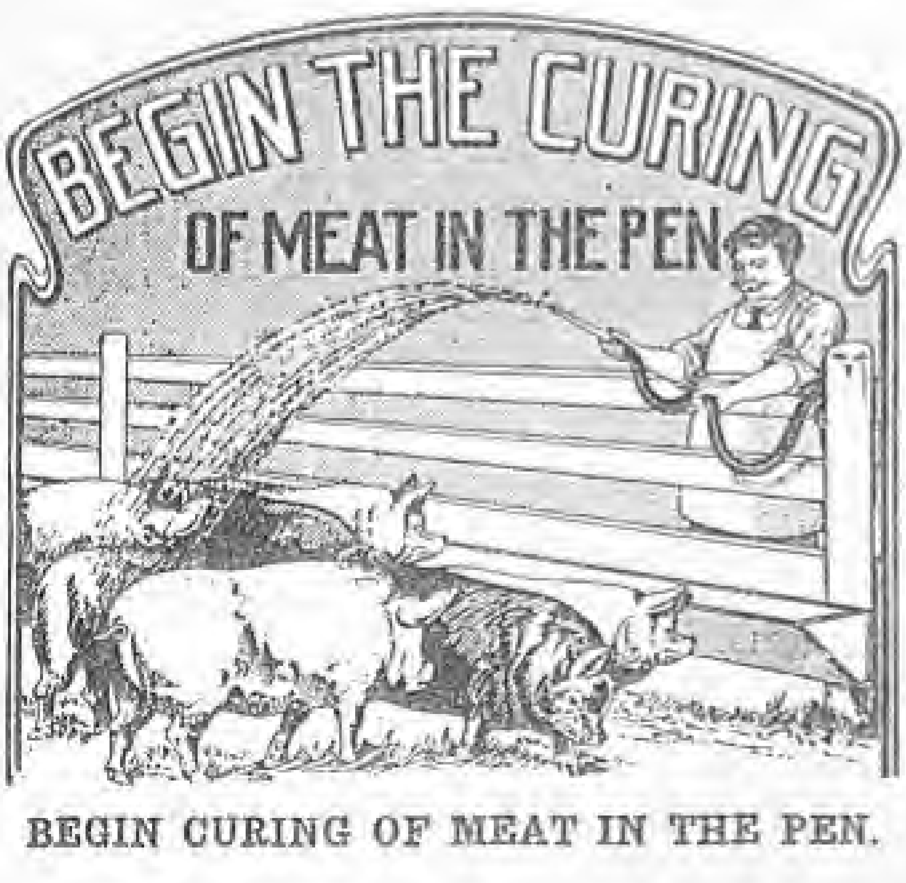
USING HELLER'S MANUAL

The following is an excellent work on meat curing and sausage making. However, it was as much Heller's catalogue as an instruction manual. The products they sold are obiously no longer to be had and for business reasons they gave no hint as to the ingredients they sold, you will have to compare their results with the results promised in other meat curing works. PRESERVATION OF MEAT AND VEGETABLES (pages 33-37) gives many indications of what Heller's products actually were. Pages 105-107 gives the formulas from Dick's (1872) which might give you some more clues.

You'll figure these out in time. But for right now, you ought to send away for Morton Salt's excellent "A Complete Guide to Home Meat Curing." Send $1.25 to the Morton Salt Co., P.O. Box 355, Argo, Ill. 60501.

They have only four preserving and seasoning products as opposed to about 20 of Heller's. Maybe Morton's does it all. At any rate, trial and error and intelligent comparisons should enable you to match just about all the processes told of in Heller's.

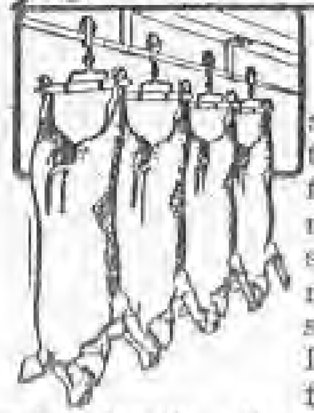


BEGIN CURING OF MEAT IN THE PEN.

Thousands of pounds of Hams, Shoulders and Sides are spoiled annually before the hog is killed. Overheated hogs, or hogs that are excited from overdriving, should never be killed until they are cooled off or have become perfectly quiet. When the temperature of a hog is above normal, the meat always becomes feverish. This is especially true of large fat hogs, and when the meat becomes feverish, it will never cure properly, but nine times out of ten will sour. The meat of feverish hogs can never be chilled as it should be, and unless the meat is properly chilled, it cannot be properly cured. Before hogs are killed, they ought to be driven into a cool place and if necessary, sprayed with cold water until they are thoroughly cooled off. This precaution is necessary only in hot weather; in winter, they simply need plenty of rest.

If it is necessary to hold the hogs for several days in the pen before they are killed, they should have an abundance of water and also a little feed. This prevents shrinkage and will also keep them from getting nervous from hunger.

CURING PORK THE YEAR AROUND



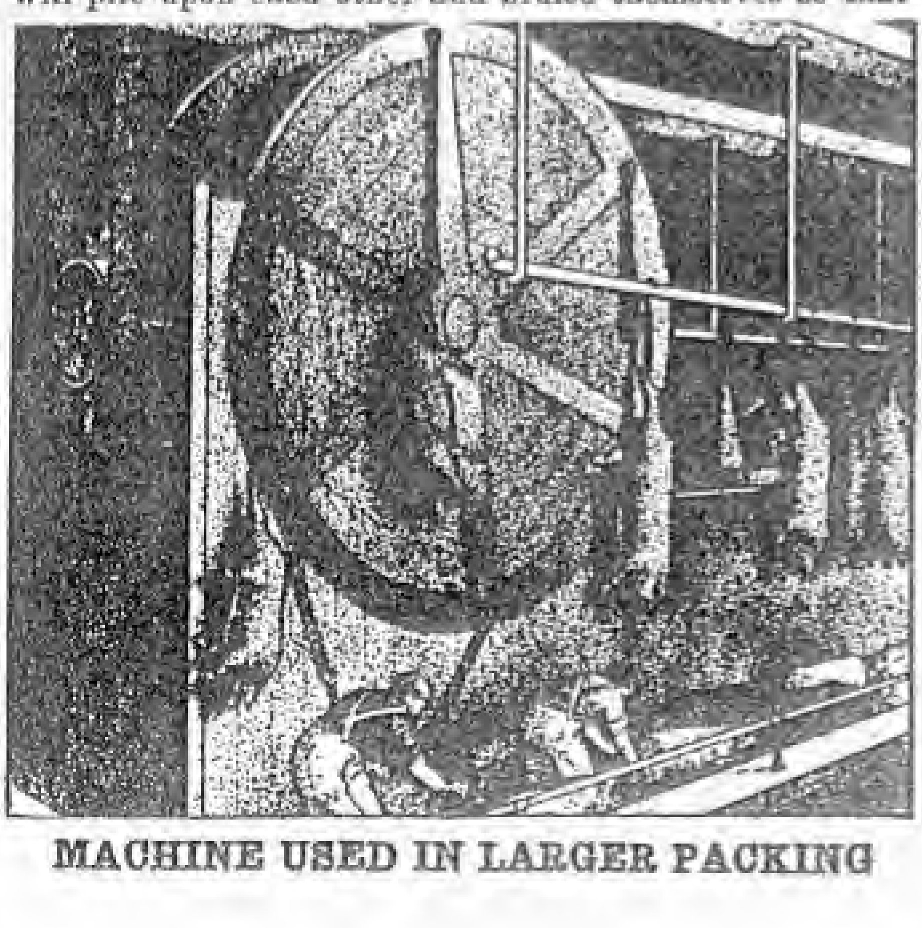
Up to a comparatively few years ago, all Pork Packing was done in the winter. Packing Houses would fill their plants during the winter months, and in the spring would smoke out the meats. In this way, most of the meat had to be sold over-salted, the shrinkage and loss to the Packer was greater and meats, therefore, had to be sold at a much higher price, besides, they were of very inferior quality.

At the present time, due to improved methods, packing can be done all the year around, and meat can be sold as fast as it is finished. In this way, cured meat can be produced at a much lower price, the money invested in it can be turned over four, five or six times a year, and the meat will be much better, taste better and more of it can be eaten because of the fact that it is more wholesome and more easily digested.

HOISTING HOGS IN A LARGE PACKING HOUSE, WITH A HOG-HOISTING MACHINE.

Great care should always be exercised when hogs are hoisted before sticking. When hogs are hoisted alive to be stuck, very often when a very heavy hog is jerked from the floor, the hip is dislocated or sprained, and blood will be thrown out around the injured joint, so the Ham will be spoiled. Great care should also be exercised in driving the live hogs, as hogs are the heaviest and weakest and easiest injured of all animals.

Special pens should be provided for them, so they are not crowded, and so they have plenty of room when they are driven to the killing pen. They should be handled very carefully, and piling up and crowding should be avoided as much as possible. Many hams are injured by overcrowding the hogs in the killing pens, for when hogs smell blood they become excited and nervous, and unless they have plenty of room, they will pile upon each other and bruise themselves so that



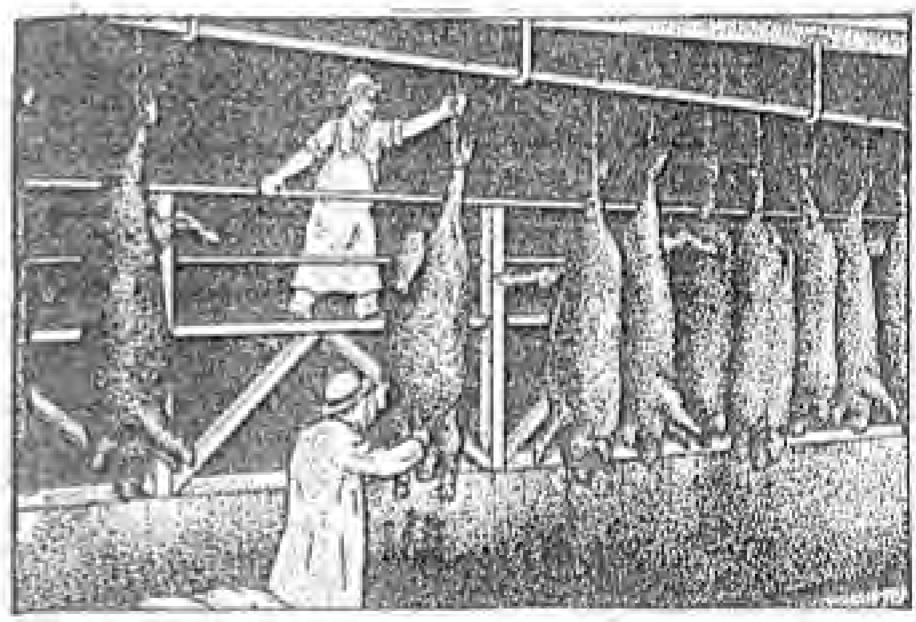
MACHINE USED IN LARGER PACKING

HOUSES FOR HOISTING HOGS.

there will be many skin-bruised hams, and the flesh will be full of bruises. Men driving hogs should never use a whip. The best thing to use in driving hogs is a stick about two feet long, to the end of which is fastened a piece of canvas three inches wide and two feet long. By striking the hogs with this canvas, it makes a noise which will do more towards driving them, without injury, than the whip which will injure and discolor the skin.

STICKING HOGS IN A MODERN PACKING HOUSE.

Men sticking hogs should be sure to make a good, large opening in the neck, three or four inches long, in order to give the blood a good, free flow. It is very necessary to sever the veins and arteries in the neck, so as to get all of the blood out of the hog. The man who does the sticking must be careful not to stick the knife into the shoulder, for if the shoulder is stuck, the blood settles there, and the bloody part will have to be trimmed out after the hog is cut up. In large Packing Houses, there is a report made out every day, of the number of shoulder-stuck hogs, and the sticker must sign this report before it is sent to the office.

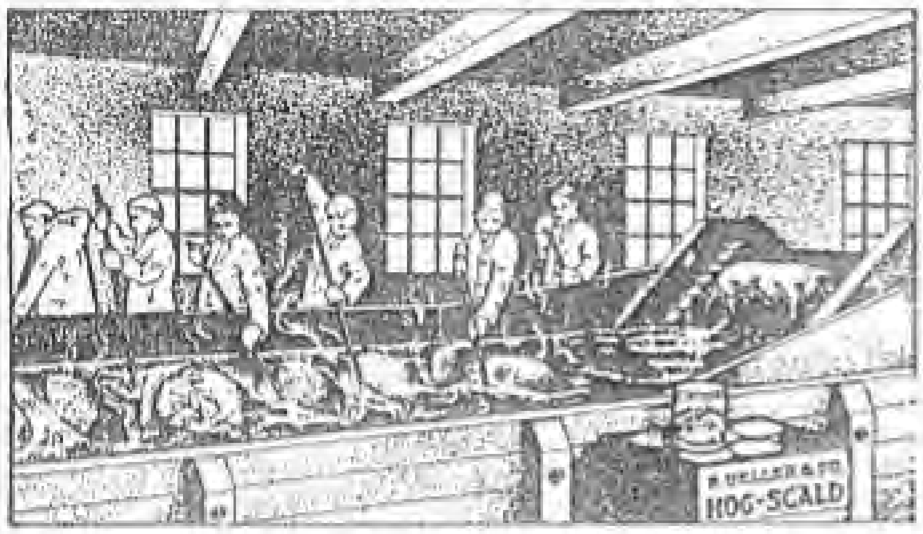


HOW HOGS ARE STUCK IN A LARGE MODERN PACKING HOUSE.

This shows the sticker the kind of work he is doing and makes him more careful. In small houses, most butchers stick the hogs on the floor and let them bleed there. Those who can possibly do it should hoist the hog by the hind leg before it is stuck or immediately after it is stuck, as the case may be, so as to allow the hog to properly bleed. When the hog is properly hoisted by one hind leg, alive, and then stuck while hanging, it will kick considerably and the kicking and jerking of the hog will help in pumping out all of the blood, making a much better bled carcass than if the hog is first stunned with a hammer and stuck on the floor. The better the hog is bled, the better the meat will be for curing.

SCALDING HOGS.

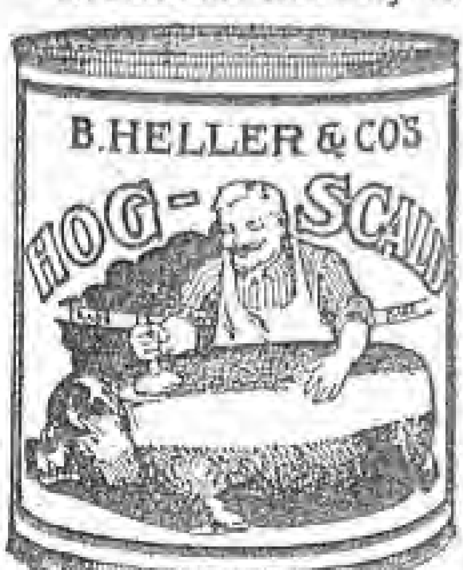
It is impossible to give the exact temperature one should use in scalding hogs, as this will vary under different circumstances. In winter the hair sticks much tighter than in summer and requires more scalding and more heat than in summer. Hogs raised in the South, in a warm climate, will scald much easier than those raised in a northern climate. A butcher will soon learn which temperature is best adapted to his own locality and the kind of hogs he is scalding.



SCALDING HOGS IN A LARGE MODERN PACKING HOUSE.

In a Packing House where a long scalding tub is used, the temperature depends entirely upon how fast the hogs are being killed. If the hogs are killed slowly, so each hog can remain in the water longer, it is not necessary to have the water as hot as when they are handled fast and are taken out of the water in a shorter time. It is, however, universally acknowledged that the quicker a hog can be taken out of the scalding tub the better it is for the meat. The hog is a great conductor of heat, and when kept in the scalding water too long, it becomes considerably heated and bad results have many times been traced to the fact that the hog was scalded in water which was not hot enough, and was kept in this water too long in order to loosen the hair. Overheating the hog in the scalding water very often causes the meat of fat hogs to sour and Packers wonder why it is that the meat has spoiled. We therefore wish to caution Packers against this, and to advise the use of water as hot as practicable for scalding hogs.

To make the hair easy to remove and to remove dirt and impurities from the skin, we recommend Hog-Scald. This preparation makes scalding easy, it removes most of the dirt and filth, cleanses the hog and whitens the skin.



In many localities, where the water is hard, Hog-Scald will be found of great value, as it softens the water and makes it nice to work with; it cleanses the skin of the hogs and improves their appearance. It is a great labor saver and more than pays the cost by the labor it saves, as it assists in removing the hair and leaves the skin more yielding to the scraper.

The skin of all hogs is covered with more or less greasy filth, which contains millions of disease germs and these extend down into the pores of the skin. If this germ-laden filth is not removed, and if it gets into the brine when the meat is being cured, it injures both the meat and the brine in flavor, and also spoils the flavor of the lard if it gets into that. Hog-Scald removes most of this filth and cleanses the skin, and for these reasons alone, should be used by every Packer and Butcher. Hams and Bacon from hogs that have been scalded with Hog-Scald are, therefore, cleaner and will be much brighter after they are smoked than when the filth of the hog remains in the pores of the skin.

Those selling dressed hogs will find Hog-Scald very valuable, as hogs that have been scalded with it are cleaner and look whiter and much more appetizing.

The use of Hog-Scald is legal everywhere. It does not come under the regulations of the Food Laws, as it is simply a cleansing agent. Hog-Scald costs very little at the price we sell it, and everyone can afford to use it. Butchers who once try it will continue its use.

SCRAPING HOGS.

As much of the hair as possible should be scraped from the hogs, instead of being shaved off with a sharp knife, as is often done. If the hog is not properly scalded and scraped and the hair remains in the skin, such hair is usually shaved off with a knife before the hog is gutted, and sometimes after the meat is chilled and cut up. After the meat is cured, the rind shrinks and all the stubs of hair that have been shaved off will stick out and the rind will be rough like a man's face when he has not been shaved for a day or so. Hams and Bacon from hogs that have been shaved instead of properly scalded and scraped, will look much rougher and much more unsightly than if the hogs are properly scalded and scraped. Therefore, Packers should give close attention that the scalding and scraping is properly done. The scraping bench should be provided with a hose right above where the hogs are being scraped and this should be supplied with hot water,

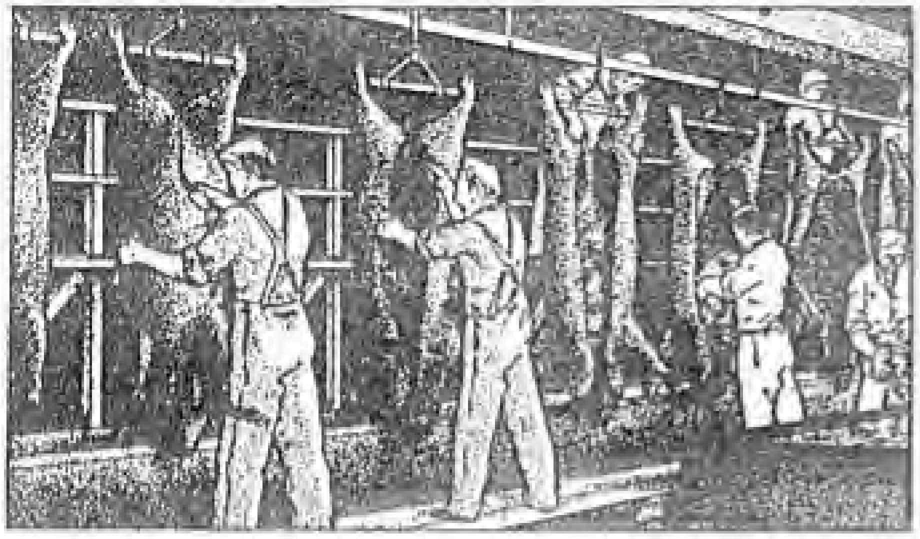
SCRAPING HOGS IN A PACKING HOUSE.

if possible, so the hogs can be rinsed off occasionally with hot water, while being scraped. The hot water can, however, be thrown over the hogs with a bucket.

After the hog has been gambrelled and hung up, either on a gambrel-stick or on rollers, it should be gutted. After it is gutted, it should be washed out

thoroughly, with plenty of cold, fresh water. As every Packer understands how to gut a hog, it is not necessary to go into details.

GUTTING HOGS IN A MODERN PACKING HOUSE.

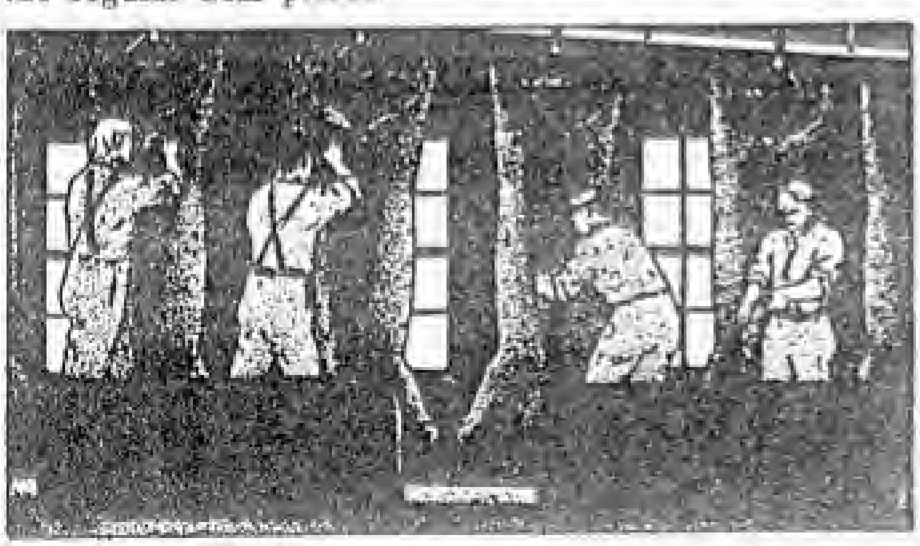


CUTTING THE HIND SHANK BONE.

a

We advise the cutting of the hind shank bone after the hog is dressed, so as to expose the marrow, as shown in cuts A and B. It is the best thing to do, as it helps to chill the marrow. The chunk of meat that is usually left on the hind foot, above and next to the knee, if cut loose around the knee, will be drawn to the ham, and when chilled, will remain on the ham instead of being on the hind foot, as shown in cut A. After the meat is cut, the bone can be sawed, in the same place where the hock would be cut from the ham later. See cut B. The hog will hang on the sinews the same as if the bone had not been sawed, except that the cut bone separates and exposes the marrow so it can be properly cooled. On heavy hogs this is quite a gain, as the chunk that would remain on the foot would be of little or no value there, but when left on the ham, sells for the regular ham prices.

b

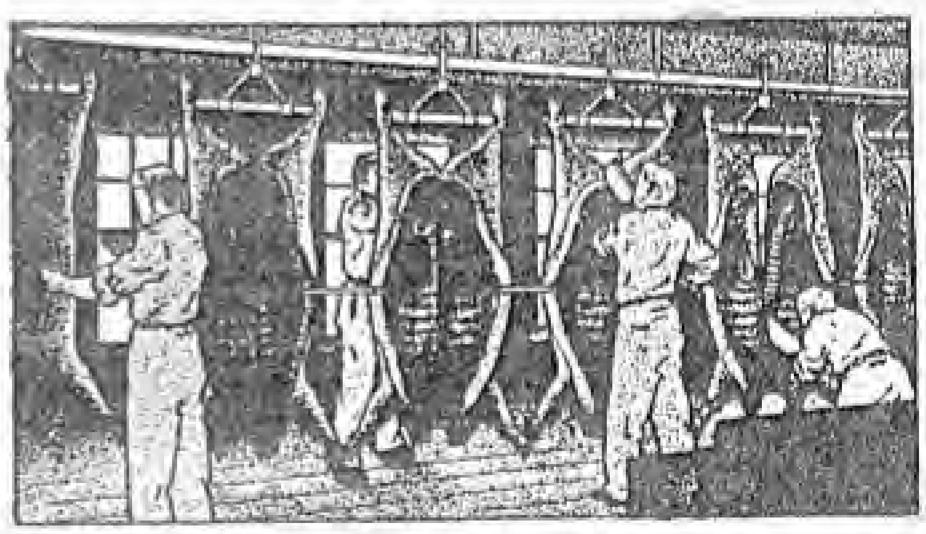


FACING HAMS AND PULLING LEAF LARD IN A MODERN PACKING HOUSE.

The first two figures in the above cut show two men Facing Hams. The first man faces the Ham at his right hand side and the second man faces the Ham on his left hand side, as the Hogs pass by.

The advantage of Facing Hams right after the hogs are dressed, is this. The knife can be drawn through the skin and through the fat close to the meat, and the fat will peel right off the fleshy part of the Ham. Between the fat and lean meat of the Ham, between the legs, there is a fibrous membrane which is very soft and pliable. When the knife is run through the skin and fat, it will run along the side of this membrane, making a clean face for the Ham. That part remaining on the Ham will shrink to the Ham and will form a smooth coating over the lean meat, which closes the pores and makes the Ham look smooth and nice when it is smoked. It also makes a much smoother cut along the skin. The skin when cut warm will dry nicely and look smooth when cured, whereas if it is trimmed after the meat is chilled, it looks rough and ragged. Facing Hams also allows the escape of the animal heat more readily. If Hams are not faced until after the Hogs have been chilled, this fat must be trimmed off and the Hams will not look nearly so smooth as they will if this tissue and fat is removed while the hog is warm.

The second two men in the opposite illustration are Pulling Leaf Lard. The Leaf Lard should always be pulled out of the hogs in summer, as it gives the hogs, as well as the Leaf Lard, a better chance to chill. During the winter months it can be pulled loose, but can be left hanging loosely in the hog, from the top. In this way it will cool nicely, and it will also allow the animal heat to get out of the hog. Most of the large packing houses pull out the Leaf Lard in the winter as well as summer, and hang it on hooks in the chill room to chill. Leaf Lard that is properly chilled, with the animal heat all taken out of it, makes much finer lard than when pulled out of the hog and put into the rendering tank with the animal heat in it.

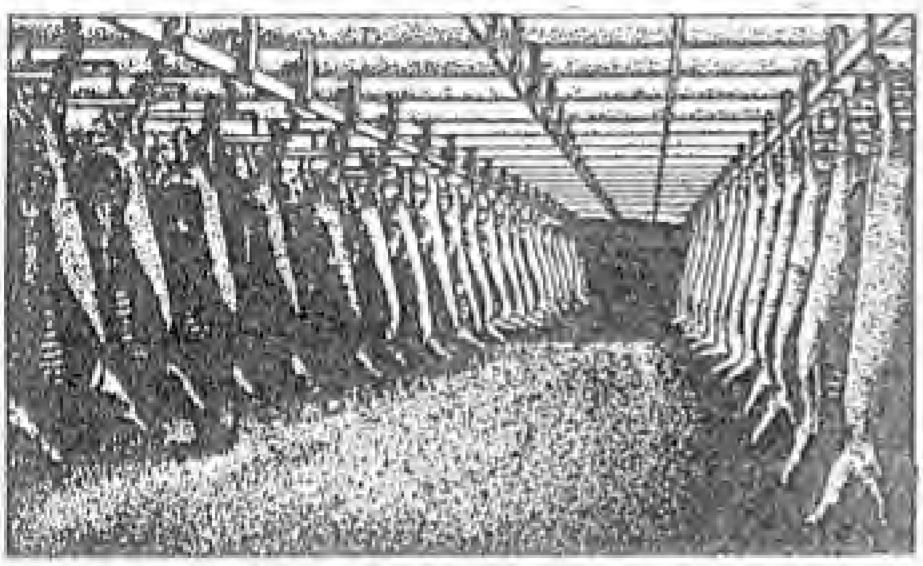


SPLITTING HOGS IN A MODERN PACKING HOUSE.

Splitting can be done in several different ways. Where the back of the hog is to be cut up for pork loins, the hog is simply split through the center of the backbone, so that one half of the backbone remains on each loin. Packers who wish to cut the sides into Short or Long Clears or Clear Bacon Backs run the knife down on both sides of the backbone, as close to the backbone as possible, cutting through the skin,

fat and lean meat; then the hog should be split down on one side of the backbone. The backbone should remain on the one side until the hog is cut up and it can then easily be sawed off with a small saw. By cutting or scoring the back in this way for making boneless side meat, the sides will be smooth and there will not be much waste left on the bone as when the backbone is split and half of it left on each side and then is peeled out after the meat is chilled and is being cut up.

VENTILATION IN HOG CHILL ROOM.



HOG CHILL ROOM IN A MODERN PACKING HOUSE.

Many chill rooms are not properly built. There should be at least from 24 to 36 inches of space between the ceiling of the chilling room and the gambrel stick, or more if possible, in order to enable the shanks to become thoroughly chilled. The animal heat which leaves the carcass naturally rises to the top of the cooler, and unless there is space between the ceiling and the top of the hog the heat will accumulate in the top of the cooler where the temperature will become quite warm; this will prevent the marrow in the shank and the joints from becoming properly chilled. It is this fact that accounts for so much marrow and shank sour in hams.

TEMPERATURE OF CHILL ROOM.

All Packers who have a properly built cooler for chilling hogs and who are properly equipped with an ice machine will find the following rules will give the best results. Those who are not properly equipped should try to follow these rules as closely as they can with their equipment.

A hog chill room should be down to from 28 to 32 degrees Fahrenheit when the hogs are run into it. As the cooler is filled, the temperature will be raised to as high as 45 or 46 degrees F., but enough refrigeration must be kept on so the temperature is brought down to 36 degrees by the end of 12 hours after the cooler is filled, and then the temperature must be gradually reduced down as low as 32 degrees by the time the carcasses have been in the cooler 48 hours. In other words, at the end of 48 hours the cooler must be down to 32 degrees.

All large hog coolers should be partitioned off between each section of timbers, into long alleys, so that each alley can be kept at its own temperature.

In the improper chilling of the carcasses lies the greatest danger of spoiling the meat. The greatest care must be given to the proper chilling, for if the carcasses are not properly chilled, it will be very difficult to cure the meat, and it will be liable to sour in the curing. Meat from improperly chilled carcasses, even with the greatest care afterwards, will not cure properly. Therefore, one of the first places to look for trouble when Hams are turning out sour is to look to the chilling of the meat, as it is nine chances out of ten that this is where the trouble started from. We have found by experience that by deviating only a few degrees from these set rules, the percentage of sour meat is surprisingly increased.

It has always been considered an absolute necessity to have an open air hanging room to allow the hogs to cool off in the open air before they are run into the cooler. It has always been considered that this saves considerable money in the refrigeration of the hogs. However, by the experiments made in some of the large Packing Houses, it has been demonstrated that this economy is very much over-estimated. There are certain conditions which must be closely adhered to for the safe handling and curing of pork products, and the most important of these is the proper temperature. In the outside atmosphere the proper temperature rarely prevails. Hogs that are left in the open air on the hanging floor over night are generally either insufficiently chilled or are over-chilled the next morning, depending upon the outside temperature of the air. We feel that it is of advantage, however, to run the hogs into an outside hanging room and to allow them to dry for one or two hours before putting them into the chilling room.

Packers who cure large quantities of hogs must see to it that their chill rooms are properly constructed and have sufficient refrigeration, so the temperature can be kept under perfect control at all times. The cooler should be partitioned off lengthwise, between each line of posts, making long alleys to run the hogs into, each one of which can be regulated as to its temperature separately from the others. The hogs can be run into one of these alleys as fast as they are killed and should the temperature get up above 50 degrees F., the hogs can be run out of this into another. The cooler in which hogs are chilled should never go above 50 degrees Fahrenheit, and a properly constructed cooler can be kept below this temperature.

While the cooler is being filled, the temperature should be held at between 45 and 50 degrees Fahrenheit, and should be kept at this temperature for about two hours after filling. At the end of two hours, all of the vapor will have passed away, being taken up by and frozen onto the refrigerator pipes, and the hogs will begin to dry. When the hogs begin to show signs of drying, or in about two hours after the refrigerator is filled, more refrigeration should be turned on, and the temperature should be gradually brought down, so that in twelve hours from the time the cooler is filled, the temperature should be brought down to 36 or 37 degrees temperature Fahrenheit. If the temperature is not brought down to 36 or 37 degrees F. in 12 hours it means a delay in removing the animal heat, and a tendency for decomposition to set in. If the temperature is brought down lower than 32 degrees Fahrenheit during the first 12 hours, the outside surface of the carcasses are too rapidly chilled, which tends to retard the escape of the animal heat. It is known, from practical experience, that where the meat is chilled through rather slowly, the animal heat leaves the meat more uniformly. Too rapid chilling on the outside seems to

clog up the outside of the meat so that the heat in the thick portions does not readily escape.

The first 12 hours of the chilling of all kinds of meat and the removal of the animal heat during this period is the most important part of the chilling. After that period, the proper temperature is of much less vital importance.

Hogs that are to be cut up for curing should never be cut up sooner than 48 hours after being killed, and the temperature of the cooler should be gradually brought down to 28 degrees Fahrenheit by the time the hogs are taken out of the chill room to be cut up. After the hogs have been in the cooler 12 hours the temperature should gradually be brought down from 36 degrees at the end of the first 12 hours, to 28 degrees at the end of 48 hours; that is, if the hogs are to be cut up 48 hours after they are killed. If they are to be cut up 72 hours after being killed, the temperature should be brought down gradually from 36 degrees at the end of the first 12 hours, to 30 degrees F. at the end of 72 hours. This would mean that the temperature should be brought down from 36 degrees to 30 degrees F., if the hogs are to be cut up at the end of 72 hours, or a lowering of six degrees in practically 58 hours; or a lowering of eight degrees, from 36 to 28 Fahrenheit, if the hogs are to be cut up in 48 hours after being killed. This means a reduction in temperature of about one degree for every eight hours. This does not mean that the six or eight degrees should be reduced in two hours' time, for if that were done the meat would be frozen.

In a large Packing House, where the cooler is properly equipped, and one has a good attendant, these instructions can be carried out in detail. When the foregoing instructions are carefully followed, the safe curing of the product will be assured.

While the curing of course requires careful attention, yet, if the chilling is not done properly, the curing will never be perfect.

The floors of coolers should always be kept sprinkled with clean sawdust, as this will absorb drippings and assist in keeping the cooler clean and sweet. If the drippings from hogs are allowed to fall on the bare floor, the cooler will soon become sour and this will affect the meat that hangs over it.

TEMPERATURE FOR CURING MEAT.

An even temperature of 38 degrees Fahrenheit is the best temperature for curing meats. Most butchers, however, have no ice machine, and, therefore, are not able to reach such a low temperature in their coolers; nevertheless, they should try to get their coolers as low in temperature as possible, and should at all times be careful to keep the doors closed, and not leave them open longer than is necessary at any time. The temperature of 37 to 39 degrees Fahrenheit is what should govern all packers who use ice machines; those who are fortunate enough to have ice machinery should never allow the cooler to get below 37 degrees, nor above 40 degrees. Many packers let the temperature in their coolers get too cold, and in winter during the very cold weather, the windows are sometimes left open, which allows the temperature to get too low. This should always be avoided, as meat will not cure in any brine, or take salt when dry salted, if stored in a room that is below 36 degrees Fahrenheit. If meat is packed even in the strongest kind of brine, and put into a cooler, which is kept at 32 to 33 degrees of temperature, and thus left at this degree of cold for three months, it will come out of the brine only partly cured. The reason for this is the fact that meat will not cure and take on salt at such a low temperature, and as the temperature herein given is above freezing point, which is 32 degrees, the meat will only keep for a short time, and then it starts to decompose when taken into a higher temperature. Anyone, who is unaware of this fact, will see how necessary it is to have accurate thermometers in a cooler, to examine them frequently, and to closely watch the temperature of the room.

The first essential point to watch before putting meat into brine, is to be absolutely certain that it is properly chilled through to the bone. Those who are not equipped with ice machinery for properly chilling meat in hot weather must spread the meat on the floor after it is cut ready for packing, and place crushed ice over it for 24 hours, to thoroughly chill it before it is packed in the salt. This will get the temperature of the meat as low as 36 to 38 degrees Fahrenheit before putting it in the brine. It is necessary that small butchers, who have no ice machines, and rely upon the ice box for a cooler, should use the greatest care to see that the meat is well and thoroughly chilled.

Thousands of pounds of meat are spoiled yearly simply for the one reason that the temperature of the meat is not brought down low enough before the meat is salted. In the summer, hams and heavy pieces of pork should never be packed by persons having no ice machine, unless the meat is first put on the floor for at least twelve hours with broken ice to thoroughly cover it. If our directions are carefully followed and Freeze-Em-Pickle is used, such a thing as spoiled meat will be unknown.

CONDITION OF MEAT BEFORE CURING.

When cured meat turns out bad, it is not always the fault of the man who has charge of the curing so much as it is the condition the meat was in when put into the brine to cure. Good results should not be expected from a man who has charge of the curing unless the meat is delivered to him in proper condition. Hogs should never be killed the same day of purchase at the Stock Yards or from the farmer. They ought to remain in the packing house pen for at least 24 hours before killing. If different lots of hogs are mixed together, they will sometimes fight, which greatly excites them. Whenever they show this fighting disposition, they should be separated.

THE TEMPERATURE OF BRINE.

Make all Pickle in the cooler, and have the water or brine of as low a temperature as the cooler when it is put on the meat. Try to have the temperature of the brine not over 38 degrees Fahrenheit when putting it over the meat. A great deal of meat is spoiled in curing by having the brine too warm when the meat is put into it.

GIVE CLOSE ATTENTION TO DETAILS.

Be careful to do everything right as you go along, for if you spoil the meat you will hardly become aware of it until it is too late to remedy your error.

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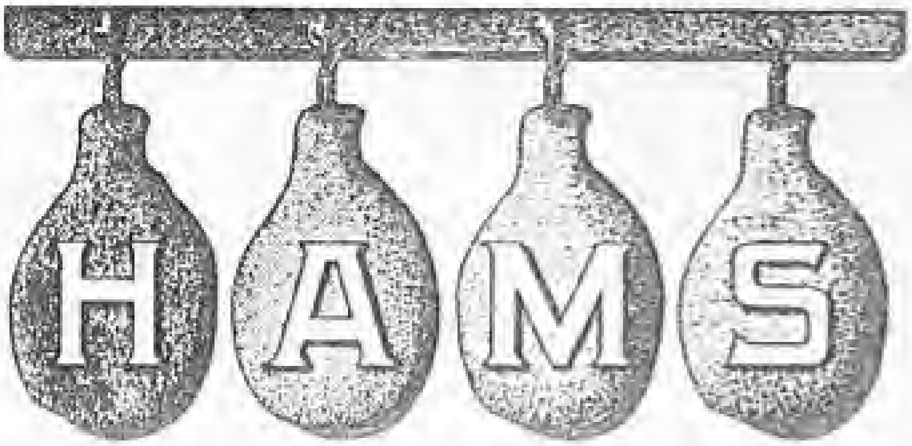


DIRECTIONS FOR CURING HAMS.

Use the following proportions of Freeze-Em-Pickle, Salt, Sugar and Water to obtain the best results in curing Hams:

Small Hams, 8 to 14 Lbs. Average.

Use for 100 lbs. Small Hams.	7 lbs. of Common Salt. 1 lb. of Freeze-Em-Pickle. 2 lbs. of Granulated Sugar. 5 gals. of Cold Water. Cure in this brine 50 to 60 **days.**

Medium Hams, 14 to 18 Lbs. Average.

Use for 100 lbs. Medium Hams.	8 lbs. of Common Salt. 1 lb. of Freeze-Em-Pickle. 2 lbs. of Granulated Sugar. 5 gals. of Cold Water. Cure in this brine 60 to 70 **days.**

Heavy Hams, 18 to 24 Lbs. Average.

Use for 100 lbs. Heavy Hams.	9 lbs. of Common Salt. 1 lb. of Freeze-Em-Pickle. 2 lbs. of Granulated Sugar. 5 gals. of Cold Water. Cure in this brine 75 to 80 **days.**

First:—Sort the Hams, separating the Small, Medium and Large.

Second:—Take enough of any one size of the assorted Hams **to** fill a tierce, which will be 285 lbs.; **then thoroughly mix together in a large pail or box the following proportions of Freeze-Em-Pickle, Granulated** Sugar and Salt:

More than 285 lbs. of Hams can be packed in a tierce, but this never should be done, as it requires a certain amount of brine to a certain amount of meat, and by placing 285 lbs. of fresh Hams in a standard tierce, the tierce will hold 14 to 15 gallons of brine, which is the proper quantity of brine for this amount of Hams. If too much meat is put into the tierce, it will not hold enough brine to properly cure the meat.

The Sugar used must be Pure Granulated Sugar. Yellow or Brown Sugar must not be used.

Use, for 285 lbs. of **Small Hams**, 3 lbs. of Freeze-Em-Pickle, 6 lbs. of best Granulated Sugar and 21 lbs. of Salt.

For 285 lbs. of **Medium Hams**, 3 lbs. of Freeze-Em-Pickle, 6 lbs. of best Granulated Sugar and 24 lbs. of Salt.

For 285 lbs. of **Heavy Hams**, 3 lbs. of Freeze-Em-Pickle, 6 lbs. of best Granulated Sugar and 27 lbs. of Salt.

How To Cure Hams in Open Barrels

When the tierces or barrels in which these Hams are cured are not to be headed up, but are left open, use half of the Freeze-Em-Pickle, Granulated Sugar and Salt dry by rubbing it over the hams in the following manner:

First:—After mixing all of the Freeze-Em-Pickle, Granulated Sugar and Salt together, sprinkle some of the dry mixture over the bottom of a perfectly clean tierce.

The Sugar used must be Pure Granulated Sugar. Yellow or Brown Sugar must not be used. When adulterated sugar is used, the brine becomes thick in two weeks; but when Pure Granulated Sugar is used it will last quite a while, depending upon the conditions under which the brine is kept.

Second:—Rub each Ham well with some of the mixture of Freeze-Em-Pickle, Granulated Sugar and Salt and pack them nicely in the tierce. Put clean boards over the tops of the hams and weight or fasten these boards down so as to keep them under the brine.

Third:—Take all of the mixed Freeze-Em-Pickle, Granulated Sugar and Salt that is left after the rubbing and use it in making the brine; it will require 14 to 15 gallons of brine, as tierces vary some, for **each standard size tierce of Hams. Make the brine by dissolving in about 14 gallons of cold water all of the mixed Freeze-Em-Pickle, Granulated Sugar and Salt that is left after the rubbing. Stir well for a minute, until it is dissolved; then pour this brine over the meat. As tierces vary so much in size, it is always best to dissolve the Freeze-Em-Pickle in a little less quantity of water, say about 14 gallons for a tierce. After this brine is added to the meat, should the tierce hold more, simply add cold water until the tierce is full. The right amount of Salt, etc., has already been added; now simply add sufficient water to well cover the meat.**

When curing a less quantity than a full tierce of Hams, cut down the amount of Freeze-Em-Pickle, Granulated Sugar and Salt and the quantity of water, according to the quantity of Hams to be cured, using all materials in the proportions given above.

QUANTITY OF BRINE TO USE FOR CURING 100 LBS. OF HAMS.

Five gallons by measure, or forty-two pounds by weight, is the approximate amount of water to use for every 100 lbs. of Hams.

A tierce, after being packed with 285 lbs. of meat, will hold about 14 to 15 gallons of water. When curing Hams in vats, or open barrels, whether in small or large quantity, always use no less than five gallons of brine to every 100 pounds of meat, as this makes the proper strength and a sufficient brine to cover the meat nicely.

THE USE OF MOLASSES AND SYRUP BARRELS IN CURING HAMS.

Never use old molasses barrels, or syrup barrels for curing meat, unless they have been first thoroughly scoured and steamed, and cleansed with our Ozo Washing Compound. It is best to use oak tierces, and always be sure that they are perfectly clean and sweet before putting the meat into them to cure.

PUMPING HAMS.

We strongly recommend the pumping of Hams, full directions for which are given on page 2655.

SHAPE OF VATS IN CURING HAMS.

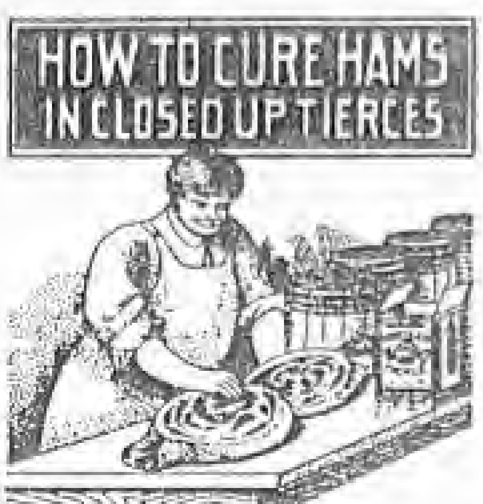
Sometimes, vats of certain shapes require more brine to cover the meat than others, and in such cases, a proportionate amount of **Freeze-Em-Pickle**, Sugar and and Salt, should be added to the necessary amount of water to make sufficient brine to cover the meat.

HOW TO OVERHAUL HAMS WHEN CURING IN OPEN PACKAGES.

On the fifth day after packing each lot of Hams, it is necessary that they should be overhauled. This must be repeated seven days later; again in ten days; and a final overhauling should be given ten days later. Overhauling four times while curing, and at the proper time in each instance, is very important and must never be forgotten, especially when curing with this mild, sweet cure. Overhauling means to take the Hams out of the brine and to repack them in the same brine. The proper way to overhaul is to take a perfectly clean tierce, set it next to the tierce of Hams to be overhauled, pack the meat into the empty tierce, and then pour the same brine over the meat.

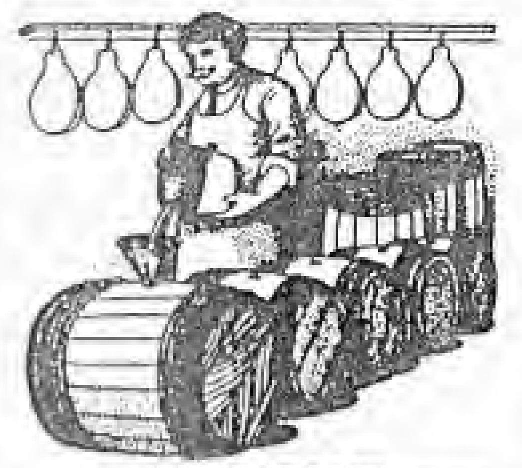
HOW TO CURE HAMS IN CLOSED UP TIERCES.

Large packers, who employ coopers, should always cure Hams in closed up tierces, as this is the best method known.



FIRST.—

First: — Mix the proper proportions of **Freeze - Em - Pickle**, Sugar and Salt for the different size Hams to be cured. These proportions are given in the table above. under the heading, "Small Hams, Medium Hams, Heavy Hams." If the tierces are to be headed up, use half of the **Freeze-Em-Pickle**, Sugar and Salt for rubbing the Hams, and the half that is left over, after the Hams are rubbed, should be dissolved in the water which is to be used to fill the tierces. Rub each Ham well before packing; put only 285 lbs. of meat in each tierce, and then head them up.



SECOND.—

Second: — Lay the tierces on their sides and fill them through the bunghole with water in which the **half of Freeze-Em-Pickle, Sugar and Salt left over after rubbing, has been dissolved.**

THIRD.—

Third:—Insert the bung and roll the tierces. This will mix and dissolve the **Freeze - Em - Pickle**, Sugar and Salt rubbed on the meat. Where the pieces of meat press tightly against each other or against the tierce, the brine does not act on the meats; but if the meats are properly rubbed with the mixture of **Freeze-Em-Pickle**, Sugar and Salt before being packed in the tierce, such surfaces will be acted upon by the undissolved mixture, so that curing will be uniform, and no portion of the piece will be left insufficiently cured even if the brine does not come in contact with it. For this reason, it is important that each piece should be carefully rubbed with the mixture of **Freeze-Em-Pickle**, Sugar and Salt before being packed in the tierce.

FOURTH.—

Fourth: — Overhaul five days after packing; again seven days later; again in ten days, and once more ten days thereafter. At each overhauling, examine each tierce for leaks; if any of the Pickle has leaked out, knock the bung in and refill. Remember to overhaul four times during the period of the first thirty-two days.

Fifth: — Overhaul the Hams in closed up tierces, simply by rolling the tierces from one end of the cooler to the other. They ought to be rolled at least 100 feet.

Sixth:—See paragraph on temperature for curing meat, page 2646.

DIRECTIONS FOR CURING SHOULDERS.

New York Shoulders:—Have shank cut off above knee, trimmed close and smooth, and square at the butt.

California or Picnic Hams are made from Medium and Heavy Shoulders, well-rounded at the butt, and trimmed as near to the shape of a Ham as possible.

Boston Shoulders are made from Light Shoulders, well-rounded at the butt, similar to California Hams.

California and Picnic Hams and Square Cut Butts, are cured in the same way, and with the same brine, the only change being in the strength of the brine and the time of curing, which must be made to suit the size of the Shoulder.

Small Shoulders.

Use for 100 lbs. Small Shoulders.	7 lbs. of Common Salt. 1 lb. of **Freeze-Em-Pickle.** 2 lbs. of Granulated Sugar. 5 gals. of Cold Water. Cure in this brine 50 **to 60 days.**

Medium Shoulders.

Use for 100 lbs. Medium-Shoulders.	8 lbs. of Common Salt. 1 lb. of **Freeze-Em-Pickle.** 2 lbs. of Granulated Sugar. 5 gals. of Cold Water. Cure in this brine 60 to 70 days.

Heavy Shoulders.

Use for 100 lbs. Heavy Shoulders.	9 lbs. of Common Salt. 1 lb. of **Freeze-Em-Pickle.** 2 lbs. of Granulated Sugar. 5 gals. of Cold Water. Cure in this brine 75 to 80 days.

The sugar used must be Pure Granulated Sugar; yellow or brown sugar must not be used.

First.—Sort the Shoulders, separating the Small, Medium and Large.

Second.—Take enough of any one size of the assorted Shoulders to fill a tierce, which will be 285 lbs.; then thoroughly mix together in a large pail, or box, the following proportions of Freeze-Em-Pickle, Sugar and Salt:

Use for 285 lbs. of **Small Shoulders**, 3 lbs. of Freeze-Em-Pickle, 6 lbs. of best pure Granulated Sugar, and 21 lbs. of Salt.

For 285 lbs. of **Medium Shoulders**, 3 lbs. of Freeze-Em-Pickle, 6 lbs. of best Granulated Sugar and **24** lbs. of Salt.

For 285 lbs. of **Heavy Shoulders**, 3 lbs. of Freeze-Em-Pickle, 6 lbs of best Granulated Sugar, and **27** lbs. of Salt.

Curing Shoulders in Open Packages.

When it is desired to cure Shoulders in Open Packages, use the foregoing proportions and in every way handle the Shoulders as directed for Hams, on page 2647.

Quantity of Brine for Curing 100 Lbs. of Shoulders.

The same quantity of brine should be used for curing Shoulders as directed for Curing Hams, full directions for which will be found on page 2647.

Quantity of Shoulders to Cure in Each Tierce.

The same quantity of Shoulders and the same amount of brine should be used as directed for Curing Hams, on page 52. The same remarks with regard to the variation in the amount of brine for each tierce, and how to be sure to have the proper amount of the right strength of brine, apply in curing Shoulders, the same as for Hams, (see page 2647) Likewise do not use Syrup and Molasses barrels for Curing Shoulders.

How to Overhaul Shoulders When Curing in Open Packages.

It is important to follow the same directions for Overhauling Shoulders that are given for Overhauling Hams. (See page 2647).

How to Cure Shoulders in Closed Up Tierces.

Follow the same directions for Curing Shoulders as given for Curing Hams in Closed Up Tierces, on page 2647.

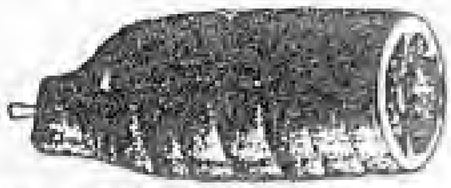
How to Overhaul Shoulders When Cured in Closed Up Tierces.

Follow exactly the same instructions as are given for Overhauling Hams when cured in Closed Up Tierces, on page 2647.

Pumping Shoulders.

Pump Shoulders as directed on page 2655.

BONELESS ROLLED SHOULDERS



Boneless Rolled Shoulders should be made in the following manner: Take the Shoulders from hogs that have been properly chilled and bone them. If the meat has been thoroughly chilled, so it is perfectly solid and chilled throughout, the Shoulders are ready to cure; but if the meat is not perfectly solid and firm on the inside, where the bone has been removed, the Shoulders should be spread out in the cooler on racks for 24 hours, until the meat is thoroughly chilled and firm.

Small Boneless Rolled Shoulders.

Use for 100 lbs. Small Boned Shoulders.	7 lbs. of Common Salt. 1 lb. of **Freeze-Em-Pickle.** 2 lbs. of Best Granulated Sugar. 5 gallons of Cold Water. Cure in this brine 30 to 40 days.

Medium Boneless Rolled Shoulders.

Use for 100 lbs. Medium Boned Shoulders.	8 lbs. of Common Salt. 1 lb. of **Freeze-Em-Pickle.** 2 lbs. of Best Granulated Sugar. 5 gallons of Cold Water. Cure in this brine 40 to 50 days.

Large Boneless Rolled Shoulders.

Use for 100 lbs. Large Boned Shoulders.	9 lbs. of Common Salt. 1 lb. of **Freeze-Em-Pickle.** 2 lbs. of Best Granulated Sugar. 5 gallons of Cold Water. Cure in this brine 50 to 60 days.

The sugar used must be Pure Granulated Sugar; yellow or brown sugar must not be used.

First:—Sort the Boneless Shoulders, separating the Small, Medium and Large, as the different sizes should be cured in separate barrels.

Second:—Take enough of any one size of the Boned Shoulders to fill a tierce, which will be 285 lbs. Then thoroughly mix together, in a large pail or box, the following proportions of **Freeze-Em-Pickle,** Sugar and Salt:

Use for 285 lbs. of **Small Boneless Shoulders, 3** lbs. of **Freeze-Em-Pickle,** 6 lbs. of Best Granulated Sugar and **21** lbs. of Salt.

Use for 285 lbs. of **Medium Boneless Shoulders,** 3 lbs. of **Freeze-Em-Pickle,** 6 lbs. of Best Granulated Sugar and **24** lbs. of Salt.

Use for 285 lbs. of **Large Boneless Shoulders,** 3 lbs. of **Freeze-Em-Pickle,** 6 lbs. of Best Granulated Sugar and **27** lbs. of Salt.

Third:—After the Shoulders have been weighed, take for example that one has 285 lbs. of **Medium Boneless Shoulders,** averaging, boned, about 10 lbs., which would make 28 pieces for a tierce of 285 lbs. Now, take the 3 lbs. of **Freeze-Em-Pickle,** 6 lbs. of Granulated Sugar and 24 lbs. of Salt to be used for the tierce of **Medium Shoulders,** and mix together thoroughly in a box or tub.

Fourth:—Rub about ¼ lb. of this mixture in each Shoulder where the bone has been removed, then roll it and tie it in the regular way. After it is rolled and tied, rub about ¼ lb. of the mixture all over the outside, and pack the Shoulders into the tierce. After the 28 **Boneless Shoulders** have been packed nicely into the tierce, put clean boards over the top of the meat and weight or fasten down these boards, so as to keep them under the brine.

The sugar must be Pure Granulated Sugar; yellow or brown sugar must not be used. When adulterated sugar is used the brine becomes thick in two weeks, but when Pure Granulated Sugar is used it will last quite a while, depending upon the conditions under which the brine is kept.

Fifth:—Take all of the mixed **Freeze-Em-Pickle,** Granulated Sugar and Salt that is left after rubbing the meat, and use it in making the brine. It will require between 14 and 15 gallons of brine, as tierces vary somewhat in size, for each standard size tierce of Boneless Shoulders. Make the brine by dissolving in about 14 gallons of water all of the mixed **Freeze-Em-Pickle,** Granulated Sugar and Salt that is left after rubbing. As tierces vary so in size, it is always best to dissolve the **Freeze-Em-Pickle,** Sugar and Salt in a less quantity of water, say about 14 gallons for a tierce. After this brine is added to the meat, should the tierce hold more, simply add cold water until the tierce is filled. The right amount of **Freeze-Em-Pickle,** Sugar and Salt has already been added, now simply add sufficient water to well cover the meat.

In curing a less quantity than a full tierce of **Boneless Rolled Shoulders,** cut down the amount of **Freeze-Em-Pickle,** Granulated Sugar and Salt and the quantity of water, according to the quantity of Boneless Shoulders to be cured.

Quantity of Brine for Curing Less Than 100 Lbs. of Boneless Rolled Shoulders.

The same directions should be followed in curing less than 100 lbs. of Boneless Rolled Shoulders as are given for Hams, on page 2647.

The Use of Molasses and Syrup Barrels in Curing Boneless Rolled Shoulders.

The remarks concerning the use of these barrels in curing Hams apply with equal force to the curing of Boneless Rolled Shoulders, and we refer to page 2647.

Shape of Vats for Curing Boneless Rolled Shoulders.

See page 72 concerning the Shape of Vats for curing Hams, as the same remarks apply in curing Boneless Rolled Shoulders.

How to Overhaul Boneless Rolled Shoulders When Cured in Open Packages.

See page2647and follow the same instructions for overhauling as are given for overhauling Hams when curing in open packages.

Pumping Boneless Rolled Shoulders.

This should not be neglected. See page2655and follow the directions closely. The Pumping of Boneless Rolled Shoulders is very important, because when they are Boned and Rolled, most of the outside surface is covered with Rind, which prevents the Brine from getting through to the meat. However, by rubbing the inside of the Shoulder with the Curing Mixture and then Pumping them before Curing, good results will always be assured.

SUGAR CURED BREAKFAST BACON

DIRECTIONS FOR MAKING SUGAR CURED BREAKFAST BACON.

Light Bellies.

Use for 100 lbs. Light Bellies.
5 lbs. of Common Salt.
1 lb. of **Freeze-Em-Pickle.**
2 lbs. of Granulated Sugar.
5 gallons of Cold Water.
Cure in this brine 20 to 25 days.

Heavy Bellies.

Use for 100 lbs. Medium or Heavy Bellies.
7 lbs. Common Salt.
1 lb. of **Freeze-Em-Pickle.**
2 lbs. Granulated Sugar.
5 gals. Cold Water.
Cure in this brine 25 to 40 days, according to size.

First:—Mix together the proper proportions of **Freeze-Em-Pickle,** Sugar and Salt, as stated above for every 100 lbs. of Bellies.

Second:—Take a perfectly clean tierce, tub or vat, and sprinkle a little of the mixed Freeze-Em-Pickle, Granulated Sugar and Salt on the bottom. The sugar used must be Pure Granulated Sugar; yellow or brown sugar must not be used. When adulterated sugar is used, the brine becomes thick in two weeks; but when Pure Granulated Sugar is used, it will last quite a while, depending upon the condition in which the brine is kept.

Third:—Take half of the mixed Freeze-Em-Pickle, Granulated Sugar and Salt and rub each piece of Belly with the mixture and then pack as loosely as possible.

Fourth:—Put clean boards over the top of the Bellies and fasten or weight the boards down so as to keep them covered with the brine.

Fifth:—All of the mixed **Freeze-Em-Pickle,** Granulated Sugar and Salt that is left after rubbing the meat should be used for making the brine.

Sixth:—For each 100 lbs. of Bellies packed in the tierce, tub or vat, add not less than 5 gallons of brine, and pour it over the meat. Five gallons of water by measure or forty-two pounds by weight, will make sufficient brine to cover, and is the proper amount for each 100 lbs. of Bellies.

Seventh:—Before putting the water over the Bellies, dissolve in it the mixed **Freeze-Em-Pickle,** Sugar and Salt left after rubbing; stir it for a few minutes until it is thoroughly dissolved, and then pour this brine over the Bellies.

Eighth:—Bellies must be overhauled three times while curing—once on the fifth day; again seven days later, and again in ten days more. Overhauling must never be neglected, if good results are desired.

Overhauling means to take the meat out of the brine and repack it in the same brine. The proper way to overhaul is to take a perfectly clean tierce or vat, set it next to the tierce or vat of Bellies to be overhauled, pack the meat into the empty package and then pour the same brine over the meat.

PUMPING BREAKFAST BACON.

Many Packers pump Breakfast Bacon when it is put into the brine, and we can heartily recommend this, as Bacon that is properly pumped will be cured in one half the time and it will have a uniform cure and color throughout and will be as well cured on the inside as the outside. Great care, however, should be exercised in making the pumping pickle. It must be made according to the formula given on page 2655 just the same as for Pumping Hams. The pieces of Bacon should be pumped in from three to five places, according to the size of the piece. Very large pieces, especially if the rib is left in them, can be pumped several times more.

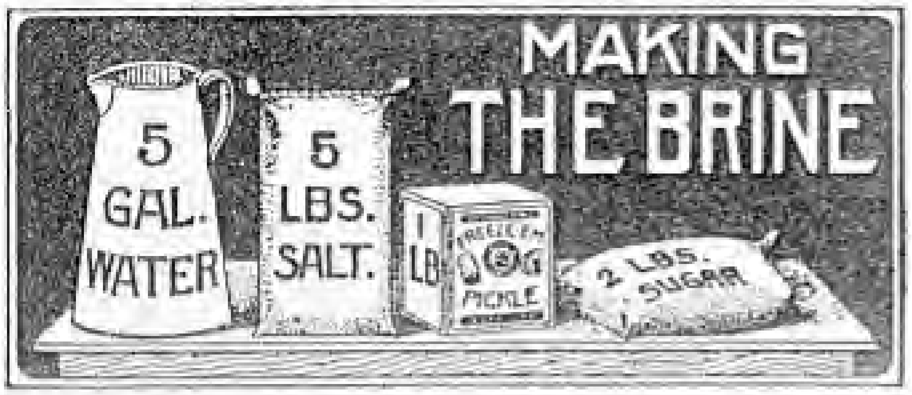
CORNED-BEEF

FEW BUTCHERS REALIZE

Few Butchers realize the importance of building up a reputation on good Corned Beef. A good trade on Corned Beef enables the dealer to get higher prices for Plates, Rumps, Briskets and other cuts which otherwise would have to be sold at a sacrifice. Corned Beef cured by the **Freeze-Em-Pickle** Process will have a Delicious Corned Beef Flavor, a Fine, Red, Cured-Meat Color, **will not be too Salty.**

To obtain the best results in curing Corned Beef, it is always advisable to first soak the meat for a few hours in a tub of fresh cold water to which a few handfuls of salt have been added. This will draw out the blood which would otherwise get into the brine. The membrane on the inside of the Plates and Flanks should be removed and the Strip of Gristle cut off the edge of the Belly Side.

If any part is **tainted, mouldy,** discolored or slimy, **it must be trimmed off,** so no slimy or tainted parts will get into the brine. If Plates or Briskets are to be rolled, a small amount of mixed Zanzibar Brand Corned Beef Seasoning, **Freeze-Em-Pickle,** Sugar and Salt must be sprinkled on the inside before rolling them. **This will give the meat a Delicious Flavor and results in a Nice Red Color and will cure it more uniformly and quickly.**



DIRECTIONS FOR MAKING FINE CORNED BEEF.

Use for 100 lbs. Plates, Rumps, Briskets, etc.:
- 5 lbs. of Common Salt.
- 1 lb. Freeze-Em-Pickle.
- 2 lbs. of Granulated Cane Sugar.
- 6 to 8 ozs. Zanzibar Brand Corned Beef Seasoning.
- 5 gals. of Cold Water.

Cure the meat in this brine 15 to 30 days, according to weight and thickness of the piece.

Retail Butchers who cure Corned Beef in small quantities, and who from day to day take out pieces from the brine and add others, should make the brine and handle the Corned Beef as follows:

To every five gallons of water add five pounds of common salt, one pound of Freeze-Em-Pickle and two pounds of granulated sugar. In summer, if the temperature of the curing room or cooler cannot be kept down as low as 40 degrees, then use one pound of sugar for five gallons of water. If the cooler is kept below 40 degrees, use two pounds of sugar. In winter the curing can always be done in a temperature of 36 to 38 degrees, and then two pounds of sugar to five gallons of water should always be used. The sugar must be Pure Granulated Sugar. Yellow or Brown Sugar must not be used. When adulterated sugar is used, the brine becomes thick in two weeks, but when pure granulated sugar is used it will last quite a while, depending largely upon the conditions under which the brine is kept.

THE SEASONING OF CORNED BEEF.

It is simple enough to add Seasoning to the corned beef, but the ability to decide what proportion of just what spices, etc., will produce the most desirable flavor requires ripe judgment and long experience. There are many butchers today who could greatly improve their corned beef if they but knew more about the proper seasoning and the proportions to use. We have worked out this problem for him in our special Corned Beef Flavor. It is a splendid combination of just those spices, etc., most suited for seasoning corned beef, and imparts a most zestful and appetizing flavor. This flavor should be added by tying it up in a piece of cheese cloth and allowing it to lay in the brine which contains the corned beef. This will flavor the brine and thus the corned beef becomes uniformly and thoroughly seasoned without any particles of the seasoning adhering to the meat.

HOW TO KNOW WHEN CORNED BEEF IS NOT FULLY CURED.

If a piece of Corned Beef is cut, before or after it is cooked, and the inside is not a nice red color, it is because the meat is not cured through. It is often sold in this condition, but it should not be, as it does not have the proper flavor unless it has been cured all the way through, which requires two or three weeks in a mild brine, depending upon the size of the piece of meat. Corned Beef pickled for four or five days in a strong brine, with an excessive amount of saltpetre in it, as some butchers cure it, is not good Corned Beef and does not have the proper flavor, although it may be red through to the center, the color being due to the large amount of saltpetre used in the brine.

The Freeze-Em-Pickle Process of curing gives the meat a different and better flavor.

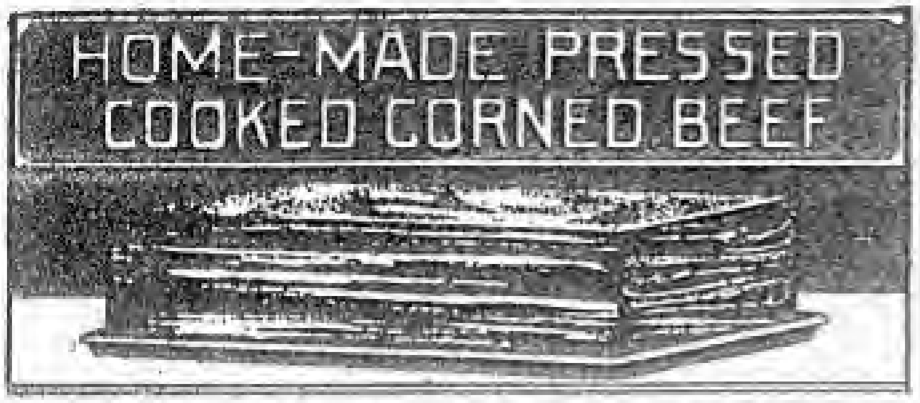
PUMPING CORNED BEEF.

We recommend Pumping Corned Beef with a Pickle Pump, before it is put into the brine. In this way the meat is cured in about half the time and it will be cured from the inside just the same as from the outside, and will be more uniform in color throughout than if cured without pumping. If Corned Beef is pumped, it should be pumped with the same pickle as for pumping Hams, formula for which is given on page 2655. The pieces of Corned Beef should be pumped in from two to four places, according to the size of the piece of meat. One will soon become accustomed to it, after pumping a few pieces. Pumping can of course be overdone, and too much brine must not be pumped into the meat; otherwise it will puff out too much and become spongy.

GARLIC FLAVORED CORNED BEEF.

Many people like Garlic Flavor in Corned Beef, and butchers who want to please their customers should keep a supply of Corned Beef both with and without the Garlic Flavor. We make a special preparation, known as Vacuum Brand Garlic Compound, with which butchers are able to give a Garlic Flavor to any kind of meat, without having any of the objectionable features that result from the use of fresh Garlic.

Vacuum Brand Garlic Compound is a powder which we manufacture from Selected Garlic. The flavor given by it is delicious, and the advantages gained by it will be thoroughly appreciated by all who use it.



DIRECTION FOR MAKING COOKED CORNED BEEF.

Take fully cured Corned Beef and cut it up into different sizes, and pack it nicely into a cooked corned beef press, sprinkling a little Zanzibar Brand Corned Beef Seasoning between each layer of meat so as to give it a delicious flavor. All Butchers' Supply Houses sell presses made especially for this purpose. After packing the pieces of Meat into the press, screw it up tight; then put the press which has been filled, into hot water, of a temperature of 180 F., and leave it there for one and a half hours, then reduce the temperature to 170 degrees and leave it there for one hour longer. A very large press might require three hours cooking before the meat would be cooked through. After the meat is thoroughly cooked, place the press in the cooler and let it remain there over night. The following morning the Corned Beef will be thoroughly chilled and can be taken out of the press.

In the summer it is a good plan to dip the cake of Cooked Corned Beef, after it is removed from the press, into Hot Lard for a second, or even Hot Tallow. This will coat it so it will not become mouldy, and it will keep much better than without dipping it.

Pressed Cooked Corned Beef is an elegant article, is a good seller and very often women would be only too pleased to be able to buy this from the butcher and would be willing to pay good prices for it if they could only obtain it. Butchers should give more attention to preparations of this kind, as they would help greatly in developing business.

DIRECTIONS FOR MAKING FANCY DRIED BEEF.

How to Cure Beef Hams and Shoulder Clots.

SMALL PIECES.

Use for 100 lbs. Small Beef Hams and Shoulder Clots.
- 6 lbs. of Common Salt.
- 1 lb. of Freeze-Em-Pickle.
- 2 lbs. of Granulated Sugar.
- 5 gals. of Cold Water.
- Cure in this brine 50 to 60 days.

MEDIUM PIECES.

Use for 100 lbs. Medium Beef Hams and Shoulder Clots.
- 7 lbs. of Common Salt.
- 1 lb. of **Freeze-Em-Pickle.**
- 2 lbs. of Granulated Sugar.
- 5 gals. of Cold Water.
- Cure in this brine 60 to 70 days.

HEAVY PIECES.

Use for 100 lbs. Heavy Beef Hams and Shoulder Clots.
- 8 lbs. of Common Salt.
- 1 lb. of **Freeze-Em-Pickle.**
- 2 lbs. of Granulated Sugar.
- 5 gals. of Cold Water.
- Cure in this brine 75 to 80 days.

The sugar used must be Pure Granulated Sugar; yellow or brown sugar must not be used.

First.—Sort the Beef Hams and Clots, separating the Small, Medium and Large.

Second.—Take enough of any one size of the assorted Beef Hams and Clots to fill a tierce which will be 285 lbs.; then thoroughly mix together in a large pail or box, the following proportions of **Freeze-Em-Pickle**, Sugar and Salt:

Use for 285 lbs. of **Small Beef Hams and Small Clots**, 3 lbs. of **Freeze-Em-Pickle**, 6 lbs. of best Granulated Sugar and 18 lbs. of Salt.

For 285 lbs. of **Medium Beef Hams and Medium Clots**, 3 lbs. of **Freeze-Em-Pickle**, 6 lbs. of Granulated Sugar and 21 lbs. of Salt.

For 285 lbs. of **Heavy Beef Hams and Heavy Clots**, 3 lbs. of **Freeze-Em-Pickle**, 6 lbs. of best Granulated Sugar and 24 lbs. of Salt.

Curing Beef Hams and Clots in Open Barrels.

Follow exactly the same instructions as given for curing Hams in Open Packages, page 2647.

Quantity of Brine for Curing 100 Lbs. of Beef Hams and Clots.

Use the same quantity of Brine and the same amount of Beef Hams and Clots as directed for curing Hams, on page ??. The same remarks apply as to variations in the size and shape of vats, and in the general handling, as given for Hams.

How to Overhaul Beef Hams and Clots When Curing in Open Packages.

Overhaul and handle exactly as directed for Hams, on page 2647.

How to Cure Beef Hams and Clots in Closed Up Tierces.

Follow the same directions in every way as given for curing Hams in Closed Up Tierces, page 2647.

How to Overhaul Beef Hams and Clots When Cured in Closed Up Tierces.

Follow exactly the directions for overhauling Hams when cured in Closed Up Tierces, given on page 2647.

Pumping Beef Hams and Clots.

Follow the general directions for Pumping, which will be found on page 2655.

Take 100 lbs. of boneless Beef Plates and cure them in brine made as follows:

5 gallons of cold water,
5 lbs. of common salt,
1 lb. of Freeze-Em-Pickle and
2 lbs. of granulated sugar.

Cure the Plates in this brine 10 to 20 days in a cooler. The temperature should not be higher than 42 to 44 degrees Fahrenheit, but 38 to 40 degrees temperature is always the best for curing purposes.

The 5 gallons of brine should be flavored by placing in it about 6 to 8 ounces of Zanzibar Brand Corned Beef Seasoning. After the meat has been fully cured in accordance with the above directions, sprinkle some Corned Beef Seasoning on the meat; then roll the meat and tie it tight with a heavy string. The meat should then be boiled slowly.

Rolled Spiced Beef should be boiled the same as hams, in water that is 155 degrees Fahrenheit.

This Rolled Spiced Beef is sold to customers raw as well as boiled. Many prefer to buy it raw and boil it at home. This style of Corned Beef makes a beautiful display on the counter and butchers will find this a profitable way of working off fat plates. Meat worked up in this way brings a good price and is a ready seller. Those liking Garlic Flavor can also add a small quantity of Garlic Compound or Garlic Condiment.

GENERAL HINTS FOR CURING MEATS.

Curers of meat, who are well acquainted with us know that we have been in a position to acquire more than the average knowledge in the curing and handling of meats. As is well known, we have been consulting chemists and packing house experts for many years; therefore, the general information which we offer for curing meats are suggested by the results of many years of practical experience.

OVERHAULING.

When curing Hams, Shoulders, and all kinds of sweet-pickled meats in open vats, overhauling is a very important feature; it must be done at least four times during the curing period. When curing in closed up tierces, the tierces must be rolled at least four times during the curing period. Bellies must be overhauled at least three times while curing in open vats, and if cured in closed up tierces, they must be rolled at least three times during the curing period. This overhauling is very necessary because it mixes the brine and changes the position of the meat in such a way that the brine gets to all parts of it.

CHILLING MEATS.

Hams, Shoulders, Bellies and other cuts must be thoroughly chilled before they are put into pickle. From one to two days before being packed, depending upon the temperature, they should be hung up or laid on a rack in the cooler, in order to draw out all the animal heat that is in them and to make them firm and ready for packing. Packers, using ice machinery for cooling, can bring the temperature low enough during the warm weather to properly chill the meat; however, it must not be frozen. If the cooler in which meats are chilled is not cold enough to make the Hams, Shoulders, Bellies, etc., firm and solid in 48 hours, it is advisable to lay the meat on the floor over night and place crushed ice over it; this will harden the meat.

Those using a common ice house can employ the crushed ice method, which is to spread the meat on the floor and throw cracked ice over the meat, allowing it to remain over night. It should always be remembered that if meat is put into brine soft and spongy, it will become pickle-soaked and in such condition will never cure properly. It will come out of the brine soft and spongy, and will often sour when in the smoke house. A great deal of meat spoils in curing only for the reason that the animal heat has not been removed before the meat is packed and placed in brine. When the animal heat is all out of the meat, the meat will be firm and solid all the way through. In order to get the best results, the inside temperature of Hams and Shoulders when packed, should not be over 36 to 38 degrees Fahrenheit. The meat should be tested with a thermometer made for this purpose before it is packed. Every curer of meat should have one.

HOW TO BOIL HAMS.

Heat the water to 155 degrees Fahrenheit. Then place the hams in the hot water and keep them in it from eight to nine hours, according to the size of Hams. Try to keep the water as near to 155 degrees as possible. By cooking Hams in a temperature of 155 degrees, very little of the fat will cook out of them

and float on top of the water, and the Hams will shrink very little. When Hams or large pieces of meat are boiled for slicing cold, allow them to remain in the water until it is nearly cold, for by so doing the meat re-absorbs much of the nutriment which has been drawn out during the cooking process. Then put them in a cooler over night, so that they will become thoroughly chilled before slicing. Hams should never be cooked in boiling water, which is 212 degrees Fahrenheit, as this is so hot that most of the fat will melt and run out of them.

USING BRINE TWICE.

The Pickle, in which Hams have been cured, but which is still sweet and not stringy or ropy, is the best brine in which to cure light bellies. Nothing need be added to it. It should be used just as it comes from the Hams. While brine in which Hams have been cured can be used once more for curing Breakfast Bacon, it should be remembered that it must not be used a second time for curing Hams or Shoulders.

ICE WATER.

Never use the drip water of melted ice from a cooler for making Pickle, as it contains many impurities, and therefore should never be used.

PUMPING MEATS.

We highly recommend pumping Hams, Shoulders and other kinds of Cured Meats. It is a safeguard in Hams and Shoulders against shank and body souring, should they, through some carelessness, be insufficiently chilled all the way to the bone, and is a protection against sour joint, and insures a uniform cure. It is also of great advantage to pump Breakfast Bacon, Corned Beef, Dried Beef, Dry Salt Meats, etc. Packers and curers, who do not use a pump and the Freeze-Em-Pickle Process, are suffering losses from sour meats, which during a year's business would mean a large profit to them.

There is a mistaken idea among many butchers and packers that pumping Hams and Shoulders is injurious to the meat. The facts do not warrant such a belief, as the best cured and the best flavored meats are those that have been pumped. When Hams and Shoulders are not pumped, it requires weeks for the pickle to penetrate through to the bone, which is the vital spot of a Ham or Shoulder. If the joints, tissues and meat around the bone are not wholly and thoroughly cured, the entire Ham or Shoulder is inferior and no good; because it furnishes a favorable seat for the development of the germs of putrefaction, which render the meat unfit for human food.

In order to always have a mild cure, sweet flavor at the joints, and uniform color, they should be pumped. Pumping with the **Freeze-Em-Pickle** Process is a safeguard against shank and body souring; it gives the inside of a Ham or Shoulder a delicious flavor, a good color, and insures a uniform cure; it cures the joints

and the meat around the bone thoroughly, and greatly reduces the period of curing. The secret and principal feature in pumping Hams and Shoulders, is to have the right kind of pumping brine. When common brine, or ordinary sweet-pickle is used for pumping, the Hams or Shoulders usually become pickle-soaked, and if the refrigerator under such conditions is not the very best, or if the Hams or Shoulders are not thoroughly chilled, the smallest degree of animal heat which may be remaining in them will start fermentation, causing the meat to sour next to the joints. It is, therefore, plain to be seen that pumping, under such conditions, instead of doing good, will in reality result in injury, and this is the reason why so many who have tried pumping meats have failed. On the other hand, when the pumping brine is made as shown herein, all of these objections are overcome, and the meat will not be pickle-soaked, nor will it become soft and flabby. The brine will be absorbed by the meat around the bone and joints so thoroughly as to leave no trace of it after the Ham is cured; it also gives the inside meat a fine red color, and a delicious flavor. **Hams that have been pumped with Freeze-Em-Pickle and cured by the Freeze-Em-Pickle Process, will not dry up and become hard when fried or cooked; when sliced cold they will not crumble, but will slice nicely and have a delicate and pleasing flavor.**

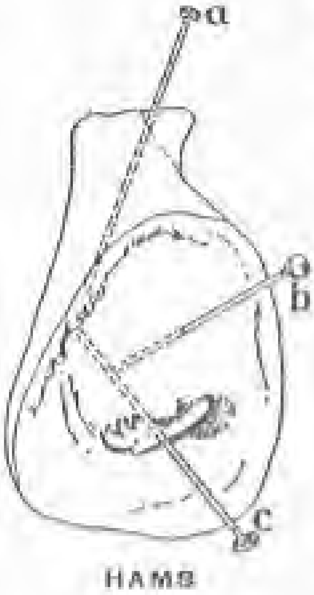
DIRECTIONS FOR PUMPING.

One gallon of pumping brine is sufficient for pumping one tierce, or 285 lbs. of meat. **Make the pumping brine as follows:**

½ lb. of **Freeze-Em-Pickle.**
1 lb of **Pure Granulated Sugar.**
2 lbs. of Salt.
1 gal. of Water.

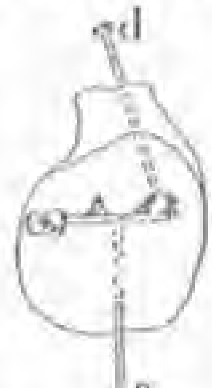
The sugar used must be Pure Granulated Sugar; yellow or brown sugar must not be used. When adulterated sugar is used, the brine becomes thick and would spoil the meat in two weeks. Stir the above thoroughly before using. As this will make a thick brine which is more than saturated, it will precipitate when left standing, therefore, when mixed in large quantities, it should be stirred occasionally. Meats should never be pumped with anything but a solution that is thoroughly saturated.

Pump the Hams or Shoulders just before they are packed, and if it is desired to rush the cure, pump them every time that the meat is overhauled. The pumping solution must be cold when pumped into the meat. Ordinarily, three insertions of the needle in the Hams are sufficient; once at the shank to the hock joint as shown at A, once to the thigh and along the bone,



HAMS

Fig. B., and once from the butt end to the joint under the hip bone and into the fleshy part, Fig. C. Solid lines show needle up to point of insertion and dotted line shows direction taken by needle after insertion. In a very heavy Ham as many as six insertions should be made, and the same with very heavy Shoulders. Three insertions of the needle into a medium size Shoulder are sufficient; one at Fig. D, one to the shoulder joint at Fig. E, and one under the blade from the end, or diagonally from the back of the shoulder toward the end at Fig. F. More insertions may be made without injury to the meat, but the above are all that are required for good results. One cubic inch of solution is enough for each insertion, and after withdrawing the needle, the hole must be squeezed shut with the thumb to prevent the solution from oozing out. Stir the solution well before starting to pump. The Pumper must be careful not to pump air into the meat. Never allow the Pickle to go below the end of sucker of pump.



SHOULDERS

USE ONLY PURE SUGAR

It will be noted that, in all of our directions for the sweet pickling of meat, we lay great stress upon the importance of using only pure sugar, free from adulterations. The very best and purest of granulated sugar should always be used, if the best results are expected. Sugar, as is well known is a great nutrient and, as a food, possesses practically the same value as starch; it is however, much more readily digested. Therefore the use of pure sugar assists in making meat food products more digestible. In preparing a sweet brine, the one great object sought to be attained is that the brine shall have the highest possible penetrative quality. Any adulterant in the sugar tends to prevent the penetration of the sweet pickled brine and lessens its efficiency in proportion as adulterants are contained in the sugar. It is only by the use of pure granulated sugar that a well-keeping brine can be produced. Many adulterants, even though they are natural adulterants, resulting from lack of proper refining of the sugar, tend to create fermentation in the brine producing a slimy and ropy condition. As is well known to those best experienced in the sweet pickling of meat, ropy and slimy brine is almost always sure to cause meat to sour.

Impurities in sugar used for producing sweet pickle will prevent the proper coagulation of the albumen in the meat uices. Coagulation does and should take place in all well cured meat. The impurities and adulterants, in other words, positively counteract the effect of the curing agents in the brine. Therefore use only the best pure granulated sugar in making all sweet pickle. The general conditions for obtaining pure granulated sugar at the present day are very much improved over those of a number of years ago, prior to the passage of the Food and Drugs Act of 1906. For instance, you can form a good idea of the purity of your sugar by dissolving a quantity in water to make a fairly thick syrup, but not using more than the water will take up. Cork this tightly and place in a dark room over night. We have seen tests made in this way, which in twenty-four hours would show a deposit of blue coloring at the bottom of the bottle, and also a considerable quantity of insoluble salts. This comes from what is known as "bluing" the sugar, but where you purchase one of the well known manufacturers products marked, "pure granulated sugar", these difficulties are seldom met with at the present time. There was a time also when sugar was frequently adulterated with crystalized glucose or as is commonly known "grape sugar." This was a very serious adulterant from the view point of the sweet pickle curing of meat, as glucose tends to ferment in brine very quickly and consequently the brine would become ropy and slimy within a very short time. This resulted in sour and soggy hams, bacon, etc., so that the purchase of cheap sugar containing impurities was never a saving, but proved very costly to the manufacturer who was persuaded to purchase low grade sugar.

It has been a common practice with some butchers in preparing sweet pickle to use molasses or syrup. This method we strongly urge our friends not to adopt. The saving will be many times lost by meat which will have to be thrown away because of ropy, fermented and sour pickle. We cannot urge upon our friends too strongly that they use only pure granulated sugar. Not only from the standpoint of keeping sweet pickle brine in good, clean condition, but from the view point of flavor and thorough cure, the use of pure granulated sugar is absolutely necessary for producing the proper kind of finished meat food products.

Sugar is considered as a natural preservative, but it must be borne in mind that sugar is used in the sweet pickle method of curing meat, not only as a preservative, but also as a flavor. Pure sugar has the property of combining with the other curing agents and by its penetrative property carries the other curing agents into the cells of the meat tissue more thoroughly. This results in the uniform action of the curing agent, producing even flavored meat as a result of the cure. Another peculiar property of pure sugar is that by its combination with the salt used in the brine it has a great tendency to prevent fermentation, thus keeping a clean, clear, sweet, penetrative brine, which will do the largest amount of work with the smallest amount of material, in producing evenly cured meat. To sum up, we will state that pure granulated sugar should take the place of molasses, syrup or any other form of sweetener because it imparts a better flavor and assists in making the brine more penetrative, thus producing best results.

HANDLING CALVES' STOMACHS OR RENNETS

The calf's stomach is divided into four compartments. The first one is known as the paunch; the second as the honeycomb stomach; the third is called the many-plies stomach and the fourth is known as the rennet bag.

The proper way to handle the rennet bag is to remove it from the balance of the stomach, turn it inside out, and clean with fresh water so as to remove the adhering contents. Great care must be taken not to scrape off or in any way remove the mucous membrane (by this is meant the many folds of thin skin) as this is the part of the stomach which has a market value. Of course the stomach must be gently and carefully washed to remove the undigested portions of food which may be contained therein, as otherwise it would very quickly decompose and become putrid. It would then be of no value whatever for any purpose. After cleansing them, dust the rennet bags all over with finely ground salt, and blow them up after having turned them inside out. Then hang them in a dry place in a current of air so that they will dry as quickly as possible.

ROPY OR STRINGY BRINE

Occasionally brine that has been made with sugar will become ropy and thick like jelly, but yet will be somewhat stringy. This is called "Ropy Brine," and can always be traced to either the use of unsuitable sugar or improper temperature of the curing room.

Yellow or brown sugar and glucose sugar will never do for curing meat. It must be Pure Sugar, and the Refined, Granulated Sugar is the best, because the impurities have been taken out.

However, even if Pure Granulated Sugar is used and the temperature of the Curing Room is too high, the brine is liable to turn "Ropy" anyway. It is, therefore, absolutely necessary for anyone who intends to cure meat in sweet brine not only to use the proper kind of sugar but also to cure in the proper temperature. Otherwise, the results will not be satisfactory, no matter what kind of a curing agent is used.

In buying sugar for curing purposes, it is advisable to order it from the wholesale grocers or from the manufacturer, and have it guaranteed to be Pure Granulated Sugar put up Especially for Preserving Purposes. This grade of sugar is on the market and is used for preserving fruits, and is the best kind of sugar to use for curing meats.

If brine has become ropy in a curing package and it is desired to use that package again, it is absolutely necessary to thoroughly scald out such package, and it is well to use Ozo Washing Powder for that purpose so as to prevent the possibility of fermentation. Otherwise, the unclean package will cause the fresh brine to turn "Ropy" even though it is made with the right kind of sugar and kept in the proper temperature.

BOILING THE BRINE

Boiling the brine improves it some, but not enough to pay for the extra trouble it makes. We recommend boiling the water, if one has the time, as it purifies it. When there is reason to believe that the water is impure, or when it is known to be tainted with vegetable matter, the brine should always be boiled, and the impurities will then float on the surface, and can be skimmed off.

CLEANSING CURING PACKAGES

All curing packages should be taken out of the cooler after the meat has been cured in them, and scalded and washed thoroughly clean with hot water and Ozo. Soda or Soda-ash may also be used, but we strongly recommend Ozo, which is a thoroughly reliable Washing Powder. When packages have been thoroughly cleaned, they should be put out in the sun and allowed to remain there for a day or two. The sun will thoroughly dry them and the fresh air will sweeten them.

SOME CAUSES FOR SOUR HAMS.

Sour Hams are sometimes caused by hanging warm meat in the same room in which the meat is cured. This should never be done. The warm carcasses raise the temperature of the curing room, thus causing the brine to get too warm. Under such conditions the meat is liable to sour in the brine. Furthermore, the brine is liable to absorb the odors from the warm carcasses, which of course is very objectionable.

Many suppose that Hams sour from getting too much smoke, but such is never the cause, as Hams will not sour from over-smoke. Smoke aids to preserve Hams and cannot cause them to sour. When Hams sour in the Smoke House the cause must be traced to the fact that they are not properly and fully cured before going into the Smoke House, and the portion that has not been thoroughly cured, which is generally close to the bone, has not been reached by the brine. In many cases, souring comes from imperfect chilling of meat before putting it into the brine; then again, the meat may not have been overhauled at the proper time and with the frequency which good curing requires.

In order to prevent souring of Hams the various stages of curing must be carried out with the utmost care. In the first place, hogs should not be killed when overheated or excited, and after they have been scalded and scraped, they must be dressed as quickly as possible, washed out thoroughly with clean water and then

split and allowed to hang in a well ventilated room until partly cooled off. They should then be run into a cooler or chill room as quickly as possible and the temperature should be reduced to 32 to 34 degrees Fahrenheit. They should be allowed to thus chill for 48 hours. When hogs are properly chilled after curing, the temperature of the inside of the Ham or Shoulder will not be more than several degrees higher than the cooler. After being thoroughly chilled, the Hams must undergo the various processes which will be found in other pages of this book which give directions for the curing of Hams and Shoulders. When these directions are closely followed, there will never be trouble from sour Hams.

HAMS AND SUPERIOR HAMS.

There seems to exist some doubt in the minds of butchers as to whether one Ham can be cured to better advantage than another, basing their opinion upon the fact that all packers have two grades of Hams, one of which is called of superior quality. Doubt has been expressed as to whether one piece of meat taken from the hog will make any better pork than that taken from another. This doubt should not obtain and could hardly exist in the minds of anyone who has carefully investigated the modern methods of packing. If such a person were to stand by the side of a Ham trimmer in a packing house and examine each Ham as it comes from the trimmer, he would be at once convinced as to the error of his opinion. There would be noticed a vast difference in the quality of Hams, even in their fresh state. Many Hams are of very coarse grain, especially those that come from boars, stags and old sows, while many other Hams are large and too fat. Those that come from poor, scrawny hogs are too small and thin, and this differentiation exists regardless of the grade or the experience in buying different lots of hogs. Perhaps there is no animal which varies so much in quality and condition of meat as the hog, and he fully represents or reflects the quality of the food from which he is made, or the results of wise or unwise feeding. Furthermore, Hams will vary in quality even after they have been graded; some medium size Hams, which is the size usually picked for the finest cure, are of much better quality than others. This will be readily admitted when it is remembered that a Ham may be of proper weight, but it can also be too fat for its weight, it can be too lean, it can have a coarse thick skin, the meat can be coarse in grain or it may be properly graded as to size, but come from an old, worn-out sow. Under such circumstances, it is not only necessary to cull the Hams, but to recull them, until the different grades are divided as to quality.

A fourteen to sixteen pound Ham from a young barrow with a fine, thin, white skin which is not too fat or not too lean, and possessing a nice, fine grained meat is fully up to grade and is taken for the superior quality of Hams. Therefore, a Ham of this description is superior in quality even before it goes into the brine for curing, and it is very easy to understand that when such a quality of Ham is carefully cured, for just the proper length of time, it will be far better than the ordinary run of Hams. Furthermore, the quality of the Hams may be deteriorated in many ways. For instance, the fourteen to sixteen pound Ham is fully cured in from sixty to seventy days, but if a packer has put up a large quantity of better grade Hams which gives him a surplus, he will hold them in the brine from ten to twenty days longer after they have been fully cured, and if they are thus kept in the brine for this additional period, they may become too salty and their fine flavor is lost. Under such circumstances the Hams must be taken out of the brine and smoked, or must be stored in a low temperature for ten or twenty days longer, but the moment they are kept beyond the full curing time they are not as good as when taken out of the cure at the moment they are fully cured. Furthermore, if a large quantity of the superior quality of Hams have been smoked and they are not disposed of rapidly enough, they begin to lose in appearance, and must again be culled and sold with the cheaper grade of Hams. If they are kept in brine longer than is necessary, they must also go into the cheaper quality.

It is, therefore, plain to be seen that what is known as the superior quality is the best Ham that the packer can turn out. As stated, the Hams are superior before they are cured. They are properly kept all through the process of curing, and the moment they are fully cured they are taken out, smoked and sold. It is only by handling Hams in this manner that it is possible to maintain a grade of superior quality. All Hams cannot be handled in this way, owing to the fluctuation of supply and demand, but the packer aims to keep them fully up to superior grade by a frequent and discriminating culling. This should convince anyone in doubt upon this question that they are erroneous in supposing that all hams are alike, and that all hog meat is high grade pork, when, in fact, it has various grades of quality.

HOW TO SMOKE PICKLE-SOAKED MEAT.

It sometimes happens that butchers leave their Hams in brine too long and they become pickle-soaked. Once in this pickle-soaked condition, it is well known that it is a very difficult matter to smoke the Hams, because, even though they are sweet when they go into the Smoke House, they will come out sour. Hams should not be left in brine over ninety days, and at the very outside not more than one hundred days, unless they are put into a freezer and kept at a temperature of 28 degrees, at which they can be kept as long as desired. But it is frequently the case that they are left in pickle five or six months in an ordinary cooler. Hams thus over-pickled cannot fail to cause trouble in the Smoke House, and we would advise that all Hams that have been left in the brine for such a long time should be washed off in warm water after first letting them soak in cold water 2 to 4 hours. They should then be hung up to dry and kept in a well ventilated room where the temperature is not too high. A room in which the circulation of air is good and which can be well ventilated by opening the windows and doors, and which does not rise in temperature above 60 to 70 degrees, would answer the purpose for drying out. It will do no harm to let the Hams hang two or three weeks before smoking. They can then be put in the Smoke House and smoked gently, using as little heat as possible. For the purpose of this light smoking, it is best to use sawdust instead of wood, or mostly sawdust, and a small amount of wood, in order to reduce the heat. The Smoke House should also be constructed in such a way that it can be sufficiently

ventilated to let cool air into it and thus make sure of a cool smoke. If Hams are smoked under such conditions, they should come out of the Smoke House without souring.

The souring of pickle-soaked Hams is due to the brine fermenting in the Hams when they are placed in the warm Smoke House. Hence the advisability of drying out the Hams well before placing them in the Smoke House, and of smoking them in a cool smoke. When Meat has been in brine a very long time and has become pickle-soaked, and is afterward soaked in cold water, the greatest of care must be taken not to keep it in cold fresh water too long, otherwise the meat will absorb more moisture. It is also a good plan to soak Meat that has been in brine 60, 70 or 80 days in cold water. When Hams are fully cured, the strength of the brine may be reduced somewhat, after which the Hams may be permitted to remain in the brine about 30 days longer. Hams are fully cured in 70 days, and may be allowed to remain in a weaker brine 30 days longer, but no longer. After 30 days they must be taken out of this reduced brine, and, if it is so desired, they may be kept in a low temperature two or three weeks longer before smoking, but at the end of that time they must be smoked.

CLEANING LARD TIERCES FOR CURING PURPOSES.

As is well known, Butchers experience a great deal of trouble when they use second-hand lard tierces for curing meats, owing to the fact that the lard soaks into the pores of the wood, where it becomes tainted and rancid. No amount of washing or scalding will thoroughly cleanse such tierces or make them as good as new. The lard is run into the tierces while it is hot and the fat naturally soaks very deeply into the wood. After these tierces are emptied and are used for curing purposes, the old lard remains in the pores and becomes rancid and contaminates the brine and also the meat.

It is a fact that many Butchers use old lard tierces for curing purposes and neglect to thoroughly clean them; and even if they have been well cleaned, it is well known that, notwithstanding every precaution taken, there is still left in the tierces a taint which affects the flavor of the meat.

USE ONLY PURE SPICES

We strongly recommend our friends to use only Pure Spices for three very good and sufficient reasons. First, for flavor; second, for uniformity, which will insure your sausage always being the same in flavor; third, for economy, as pure spices are cheapest in the final analysis.

Then again, the Pure Food Laws should not be overlooked. In States where the use of cereal in sausage is forbidden, the one safe-guard against prosecution is to use absolutely Pure Spices and avoid so-called sausage seasonings which contain cereals as an adulterant. In our laboratory we have repeatedly found cases where as much as 50% bread crumbs were mixed into spice to cheapen it. The bread crumbs mixed with the seasoning into the sausage meat would be detected by the chemists and microscopists of the various State Pure Food Departments, making the butcher who used such seasonings liable to prosecution for adding adulterants to his sausage.

If you will bear in mind that spices are of value only to the extent that they contain the flavoring principle of the particular Spice, you will readily understand that buying adulterated Spices is just throwing so much money away. For instance, in the case of White Pepper, there is an Oil of Pepper and certain resins. Presuming that you do pay the legitimate wholesale price for the sausage seasoning which contains only the best Singapore White Pepper and do have to pay a few cents a pound more than for one which is diluted down with 50% bread crumbs, the pure and unadulterated Spice is by far the cheapest in the end. You are also assured of always obtaining a uniform flavor in the finished sausage meat.

There is probably no other material in use by the butcher that is as liable to adulteration as Spice. To the average user the adulteration is very difficult to detect, because the aroma of the Spice is there and the adulterant is so cunningly ground and mixed in with the Pure Spice that, to the naked eye, it looks like the genuine article. But once the chemist or the microscopist secures a sample of these adulterated goods one glance through the microscope and a simple test for starch, which comes from the added cereal present, is sufficient. These adulterations not only occur in the largest used Spice like Pepper, but many of the other higher priced Spices like Cinnamon, Nutmeg, Cloves, Mace, Allspice, Ginger, etc., are equally the subject of adulteration at the hands of unscrupulous manufacturers and jobbers whose only object is to undersell the legitimate importer and grinder of real 100% Spice.

A CHEAP TEMPORARY SMOKE HOUSE.

This illustration will give some idea of how a temporary smoke house can be rigged up with very little trouble, which will answer the purpose nicely.

Very often it becomes necessary for a butcher to re-smoke some bologna that has been shipped to him from a packer, and it is sometimes necessary to re-smoke Hams and Bacon. Also, a butcher will often want to cure a small quantity of meat and would like to smoke it.

When butchers who are not equipped with a smoke house have to do this, they may be at a loss to know what to do.

Take a clean sugar barrel and knock out the bottom; then set the barrel on top of a box about four feet long, one or two feet high and as wide as the barrel. If a box of this shape cannot be obtained, a large dry goods box will answer. Bore auger holes through the box under the barrel, to let the smoke through. Get a large piece of tin, galvanized iron or sheet iron, about one foot wide and 2 feet long and bend it into the shape of a pan, or take an old roasting pan. Dig a hole in the ground at the front end of the box, so fire can be put onto this piece of tin, sheet iron or pan and then placed under the box with the fire on it. After the fire is placed under the box, place a board

over the hole. All crevices must be banked with dirt around the box, to keep the smoke in.

The meats to be smoked should be hung on sticks with long strings on them, so as to let them down to about the middle of the barrel. Cover the barrel up with a gunny sack, so as to let a draft pass through and still retain the smoke in the barrel.

This makes a first class temporary smoke house with very little trouble and expense.

HOW TO KEEP HAMS, SHOULDERS, BACON, DRIED BEEF, AND ALL KINDS OF PICKLED MEATS IN BRINE FOR A YEAR OR LONGER.

All kinds of pickled meat after it is fully cured, if stored in a cooler in which the temperature is kept down to 28 degrees can be kept in this cooler for a year, or even longer, and when removed will come out similar to fresh cured meat. During the time when Hams and other meats are low in price, they can be stored in a freezer, and kept there until such a time as they are in greatest demand and will sell at the highest price. This enables the packer to reap a larger profit. At a temperature of 28 degrees, the meat will not freeze after it is cured, and the brine of course does not freeze, as salt water will not freeze, at that temperature. When meat is taken out of such cold storage to be smoked, it should first be soaked for three to five hours in fresh water, then washed in boiling hot water and smoked the same as regular fresh cured meat.

WASHING CURED MEAT BEFORE SMOKING.

Hams, Shoulders, Bacon and all cured meats whether dry salted or cured in brine, should be washed in hot water and scrubbed with a brush before being put into the smoke house. This is very important, as the meat thus scrubbed will come out of the smoke looking much better. The water should be as hot as the men can work with. The hotter the water, the better the meat will look after being smoked.

BRINE ABSORBS FOREIGN ODORS

Warm carcasses of meat should never be put into a cooler where meat is being cured in open vats, as the cold pickle will absorb the impure animal heat, and odors which these carcasses give off. Never allow sour pickle of any kind to remain in the curing room, as cold brine or water will absorb all foreign odors. To demonstrate this, take a glass of cold water, set it on a table next to a glass of tainted brine, and cover both with a bucket or pan; allow them to remain over night, and the next morning the cold water will have the same odor as the tainted brine. This will easily prove how meat can be tainted when curing in open tierces or vats, if anything sour or spoiled is in the cooler; therefore, curing rooms must be kept as clean as possible.

HOW LONG BRINE SHOULD BE USED

The length of time that brine should be used depends entirely upon the quantity of brine that you have in the barrel and the amount of meat that you put in each week. When the meat is packed solid it takes about 5 gallons of brine to each 100 pounds of meat. On the other hand if you put 25 gallons of brine in a tierce in which you place but a few pieces of corned beef from time to time as the meat accumulates your brine would be sufficient to cure 500 pounds of meat; if the barrel was nice and clean, the meat in good condition when put in the brine, and generally speaking conditions are favorable it will cure a great deal more than 500 pounds.

The brine may be used until it begins to get thick and show foam on the top; then of course it is advisable to make a new brine, at the same time washing the tierce out thoroughly.

DRY SALT MEATS.

Short Ribs (Regular) are made from the sides of the hog, between the Ham and Shoulder, having the loin and ribs in, and backbone removed.

Extra Short Ribs are made from the sides of the hog, between the Ham and Shoulder, with loin taken out, but belly ribs left in.

Short Ribs (Hard) are made from the sides of the hog, between the Ham and Shoulder, having the loin, ribs and backbone in.

Short Clears are made from the sides of the hog, between the Ham and Shoulder, having the loin in, and ribs and backbone removed.

Extra Short Clears are made from the sides of the hog, between the Ham and Shoulder with loin and all bones taken out.

Long Clears are made from sides, Ham being cut off, but Shoulders left in, back bone and ribs removed, shoulder blade and leg bone taken out, and leg cut off close to the breast.

Extra Long Clears are made from sides, Ham being cut off, back bone, loin and ribs removed. Shoulder blade and leg bone taken out and leg cut off close to the breast.

Short Clear Backs are made from the backs of hogs with the loin left in, but ribs and backbone removed; also known as **Lean Backs** and **Loin Backs**.

Short Fat Backs are made from the fat backs of prime hogs, being free from lean and bone, and properly squared on all edges.

Dry Salt Bellies are made from medium size hogs, cut square and well trimmed on all edges, with ribs left in.

Dry Salt Clear Bellies are made from medium size hogs, cut square and well trimmed on all edges, with ribs taken out.

HOW TO CURE DRY SALT SIDE MEATS.

First—Thoroughly chill the hogs so they are firm and solid. This will require letting them hang in the cooler after they are killed about 48 hours. Should the sides not be perfectly solid and thoroughly chilled, when cut up, spread them on the floor of a dry cooler for 24 hours, which ought to be long enough in a fair cooler to thoroughly chill them.

Second:—Make a tub of brine, using 15 lbs. of salt and 1 lb. of **Freeze-Em-Pickle** to each 5 gallons of brine.

Third:—Take a pickle pump, and pump some of the above brine into the sides along the backbone, being careful to get it all through the thick part.

Fourth:—Dip the sides into the tub of brine, and then lay them on a table or trough and rub thoroughly with dry salt. They must be dipped in brine, so that the **Freeze-Em-Pickle** will get all over the meat, and so the salt will adhere to the meat.

Fifth:—Clean the floor in the cooler or curing room with Ozo Washing Powder; sprinkle the floor lightly with salt; and then pile the sides one on top of the other with the meat side always up. Between each side spread a layer of salt, and see that all parts of the meat are covered with the salt. The more salt put on it the better.

Sixth:—Five days after salting the sides, shake off the salt, and pump them again in the same manner as when first salting; dip into the vat of brine, and dry salt again; then stack up the same as in the first instance, putting salt between each layer, and repeating this overhauling every ten days until the sides are cured.

HOW LONG TO CURE DRY SALT SIDES.

Light sides will fully cure in from 30 to 35 days, and should be resalted three times, which with the first salting received by them, will give them four saltings during the curing period. These saltings are given on the first day, the fifth day, the fifteenth day, and the twenty-fifth day.

HOW LONG TO CURE HEAVY DRY SALT SIDES.

Heavy sides will be fully cured in from 50 to 60 days, according to size, and should be resalted five times during the curing, as follows: The first day, the fifth day, and then every ten days. After 45 days, the meat need not be rehandled, and can then remain in the cooler piled up, as long as one wishes to keep it. It should not be taken out of the cooler, however, until it has been in salt 50 to 60 days, according to the season of the year.

TEMPERATURE OF COOLER FOR DRY SALTING.

Full information as to the temperature of the cooler for dry salting will be found on page2646under the head "Temperature."

DRY SALT CURING BY BUTCHERS WHO HAVE NO ICE MACHINE.

Small butchers, who have no ice machines, and simply use an ice box for a cooler, must use the greatest care to see that the meat is well chilled before salting, and they must also use plenty of salt. For the special benefit of small butchers, we will say that we fully realize the conditions which surround them, and we are well aware that they cannot get the temperature in an ice box as low as with an ice machine; but nevertheless, they can always cure meat with the **Freeze-Em-Pickle** process, and get better results.

DESCRIPTION OF BARRELED PORK.

Mess Pork is made from the sides of well-fattened hogs, split through the backbone, and cut in strips about six inches wide.

Mess Pork Short Cut is made from the backs of prime hogs, split through the backbone, backbone left in, and bellies taken off; cut into pieces six inches square.

Clear Back Pork is made from the fat part of the backs of prime hogs, being free from lean and bone, even in thickness, and cut into pieces about six inches square.

Family Pork Lean is made from the top of shoulders, when cut into California Hams. It has one-half of the blade bone in, and is about two-thirds fat, and one-third lean.

Clear Bean or Butt Pork is made from the fat cheek or jowl, cut square.

Clear Brisket Pork is made from the Briskets of prime medium weight hogs, ribs removed and pieces cut about five inches wide.

Rib Brisket Pork is made from the Briskets of prime medium hogs, ribs left in, and cut into pieces about five inches wide.

Loin Pork is made from the end of the back next to the Ham, with both lean and fat, and has a portion of the tail bone in.

Pig Pork: Light selected boneless Bellies cut into five inch pieces, trimmed square.

Belly Pork: Selected heavy weight Bellies, cut into five inch pieces, with ribs left in.

Extra Short Clear Pork is made from the sides of hogs, with the loin and backbone removed, and the Belly ribs left in, cut into strips five inches wide, squared at each end.

Lean End Pork is made from selected medium weight Rib Bellies, cut into strips five inches wide.

DIRECTIONS FOR CURING BARRELED PORK.

Never pack more than 190 lbs. of pork in an ordinary pork barrel.

First:—If it can possibly be obtained, it is always

best to use coarse rock salt, or coarse evaporated salt, which is made especially for this purpose; but if coarse salt cannot be obtained, any salt will answer the purpose. In packing it is necessary to use 35 lbs. of salt for each barrel, over and above the salt used in the brine.

Second:—Take a perfectly clean pork barrel, and throw three handfuls of salt on the bottom of the barrel.

Third:—Put in a layer of pork; throw three handfuls of salt over this layer.

Fourth:—Keep packing layer after layer, until the 190 lbs. of pork are packed in the barrel, and while packing put three handfuls of salt over each layer of the pork.

Fifth:—The following are the proper proportions for brine for 190 lbs. of pork: Put 10 gallons of cold water in a keg or tub; dissolve in this water 2 lbs. of **Freeze-Em-Pickle** and 30 lbs. of salt. Stir this well until it is all dissolved, and then pour the brine over the pork which has been packed as above directed.

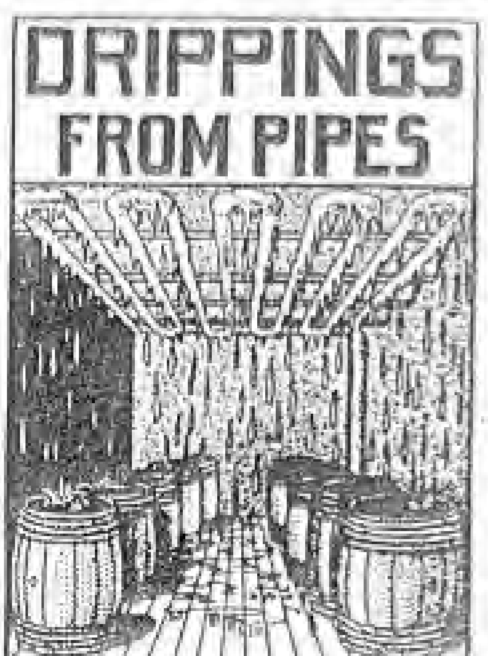
Sixth:—If the barrels are to be headed up, head up first, and then put in the brine through the bung hole.

BARRELED PORK NEED NOT BE OVERHAULED.

Barreled Pork when packed in accordance with these directions with **Freeze-Em-Pickle** and **Salt**, and then stored in a cooler, will not spoil, but will cure with a delicious flavor. It is not necessary that barreled pork should be overhauled; overhauling is required only for dry-salt and sweet-pickled meats. After the pork is fully cured, which will vary according to the size of the pieces, from 40 to 60 days, the pork can be shipped anywhere, into any hot climate and will remain in perfect condition without spoiling.

Extreme care must be exercised to thoroughly chill the pork before it is packed; if animal heat is left in the pork, it will not cure properly, any more than will hams when they are put into brine, with the animal heat left in them. Good results when curing barreled pork, cannot be expected if the meat is not in proper condition when packed.

DRIPPINGS FROM REFRIGERATING PIPES.

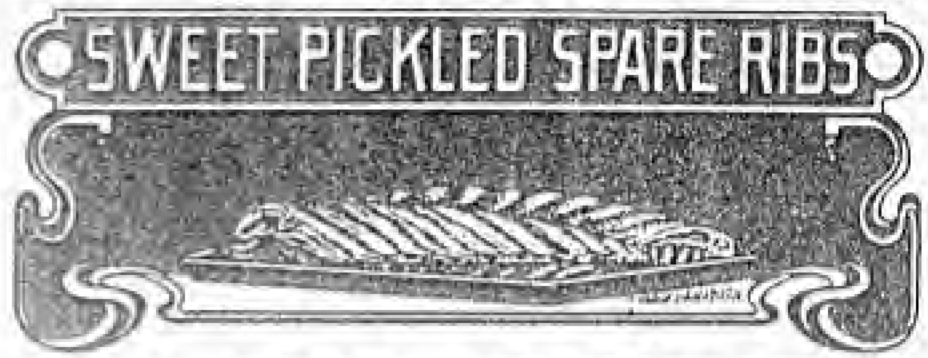


Never allow the drippings from refrigerating pipes along the ceiling, or from ice chambers, to drip into open vats containing meats while curing, as they will reduce the strength of the brine and make no end of trouble.

Keep the cooler as dry and as clean as it possibly can be kept. A damp, dirty cooler breeds millions of germs. These germs affect the brine and the curing of the meat.

TEMPERATURE FOR BARRELED PORK.

It is necessary that the greatest care should be exercised not to let the pork freeze while curing. Brine for barreled pork will not freeze at the freezing point of water, but the meat in the brine will freeze, and will not cure if the temperature is lower than the freezing point for any length of time. See instructions as to Temperature to be found on page 2646.



RECIPE FOR CURING SPARE RIBS.

For each 100 pounds of spare ribs make the brine as follows: 5 pounds of common salt, 1 pound of **Freeze-Em-Pickle**, 2 pounds of best granulated sugar and 5 gallons of cold water.

Cure in this brine from 10 to 12 days. The temperature of the cooler in which the spare ribs are cured can be anywhere from 36 to 42 degrees, but it should not vary from this range of temperature. It is best to leave the spare ribs in the cure from 10 to 12 days, though they will be cured sufficiently in 7 to 8 days.

If the above method is carefully carried out, the result will be a fine, mild, sweet cure and not too salty.

Before placing the spare ribs in the brine they should be handled in the same manner as hams and shoulders. In other words, they should be rubbed in half of the above quantity of salt, **Freeze-Em-Pickle** and sugar, and the mixed **Freeze-Em-Pickle**, sugar and salt that is left after rubbing should be used for making the brine.

HOW TO CURE BEEF TONGUES.

First:—Cut the tongues out of the heads as soon as possible, and with warm water scrub off all the slime and dirt, with a stiff brush; hang up in a cooler on a hook at the gullet, to make the tongues thick instead of long and thin.

Second:—Let them hang for at least 24 hours in a cooler.

Third:—When the tongues are thoroughly chilled and firm, cut off the surplus fat and square the tongues at the gullet by trimming off all ragged pieces.

Fourth:—Put them into a strong common salt brine to beach them, and leave them in this brine from 10 to 20 hours.

Fifth:—Take them out of this brine and rub the slime off the tongues and out of the gullet, and also rub the gullet with dry salt.

Sixth:—If only a few tongues are to be cured make a barrel of pickle, as follows, and simply throw the tongues into it: For every 5 gallons of water, add 1 lb. of Freeze-Em-Pickle, 2 lbs. of Pure Granulated Sugar, and 7 lbs. of Common Salt.

Seventh:—Where large packers wish to pack tongues in tierces, the tongues should be handled as follows: Weigh out 285 lbs.; then mix together in a box or tub the following:

3 lbs. of Freeze-Em-Pickle.

6 lbs. of Best Granulated Sugar.

21 lbs. of Salt.

Eighth:—Rub each tongue with some of this mixture and pack as loosely as possible in the tierce, using about one-half of the mixture of Freeze-Em-Pickle, Sugar and Salt for rubbing, and the other half for making the brine. It will require between 14 to 15 gallons of brine to fill the tierces, some tierces vary in size, therefore dissolve the balance of the mixture of Freeze-Em-Pickle, Sugar and Salt in about 14 gallons of water, and pour over the tongues, should the tierce hold more simply add enough cold water to cover all the meat as the right amount of salt has already been added.

Ninth:—If the tierces are to be headed up, the heads should be put in, and the brine should be poured into the tierce through the bung hole. The overhauling of tongues is just as important, as is the overhauling of hams and shoulders. They should be overhauled in the same manner, and the same number of times. By reference to directions for curing hams and shoulders, which will be found on previous pages, all the necessary instructions can be followed. To give the tongues a proper flavor, they ought to cure from 50 to 60 days.

GARLIC FLAVORED BEEF TONGUES.

Many like Garlic Flavored Tongues, and this desire can be fully satisfied by adding about two tablespoonfuls of Vacuum Brand Garlic Compound to each tierce of tongues; add it to the brine before it is poured over the tongues. This will give them a delicious flavor which will be relished even by people who do not like fresh Garlic.

HOW TO CURE HOG TONGUES.

Hog Tongues should be handled and cured in exactly the same manner as beef tongues. The brine should be made of the same strength and in the same manner, and when so made, it will cure the hog tongues in about 30 days. The directions for curing Beef Tongues can be used for curing Hog Tongues in every particular.

CURING BEEF CHEEKS FOR CANNING.

First:—The cheeks should be cut out of the head immediately after the beef is killed, all the fat should be trimmed off, and then the cheeks should be twice cut, lengthwise, through the outside muscles.

Second:—They should be then thrown into ice water to which has been added some salt, and they should be allowed to remain there for an hour or two. This will draw out all the slime and blood.

Third:—The cheeks should then be put on a coarse wire screen, or perforated galvanized iron pan placed in a cooler and spread out as thinly as possible, so as to give them a chance to thoroughly chill. A thorough chilling in a cold cooler will require 24 hours.

Fourth:—The cheeks should then be salted, and packed into tierces; 285 lbs. should be put into each tierce.

Fifth:—Handle the cheeks as follows: For each 285 lbs., mix in a box or tub, 3 lbs. of Freeze-Em-Pickle, 6 lbs. of Granulated Sugar and 15 lbs. of Common Salt.

Sixth:—Then put 285 lbs. of cheeks on a table and take half of the mixture of Freeze-Em-Pickle, Granulated Sugar and Salt and mix it with the cheeks thoroughly; then shovel into tierces.

Seventh:—If the tierces are to be headed up, put the heads in and take the balance of the mixture of Freeze-Em-Pickle, Sugar and Salt and dissolve it in 15 gallons of cold water, which pour into the tierces through the bung hole. Insert the bung, and roll the tierces. This will mix and dissolve the Freeze-Em-Pickle, Sugar and Salt. Overhaul in closed up tierces simply by rolling them from one end of the cooler to the other. They ought to be rolled at least 100 feet.

Eighth:—If the tierces are to remain open, take 15 gallons of water in which dissolve the remaining mix-

ture of **Freeze-Em-Pickle,** Sugar and Salt, and pour this brine over the cheeks; put boards over the top to keep the meat from floating or from coming out of the top of the barrel. At the end of five days after salting, the cheeks must be overhauled and rehandled by transferring them to another tierce with a large fork made for such purpose; this should be repeated every five days, viz., on the fifth day, on the tenth day and on the fifteenth day. After each overhauling, the same brine is always used to pour over the meat. If the cheeks are to be kept for any length of time, they should have another overhauling 25 to 30 days from the day they were packed. Cheek meat slime considerably, making it difficult to cure. When the cheeks are overhauled, if the pickle is thick and ropy, new brine of the same strength as the original brine will have to be made and poured over them, instead of the old brine. The cheek meat must be thoroughly washed in cold water before being put into fresh brine.

CURING HOG LIVERS.

Cut off plucks and chill livers thoroughly; then pump them in three or four places with a long slender open nozzle, about 3/16 to ¼ inch in diameter, using a pumping pickle made as follows.

1 lb. of Freeze-Em-Pickle.
12 lbs. of Common Salt.
5 gal. of Water.

Stick the nozzle of the brine pump into the different veins on the lower side of the livers and pump them until they swell up from the pressure of the brine; then lay them out on a rack for 24 hours in a cooler and allow the blood to ooze out of them.

On the next day after the livers have been pumped, pack them in a 60 deg. common salt brine; nothing else need be added. Those not having a Hydrometer for testing brine can make the brine by dissolving 15 lbs. of salt in 85 lbs. of water, this makes a 60 degree brine. In this way, the livers can be kept for a long time. When pickling livers, it is absolutely necessary that all animal heat should be extracted from them, and that they should be properly chilled and cooled, otherwise, they will not keep.

CURING BEEF LIVERS.

Cut off plucks and chill livers thoroughly. Pump the curing brine into them in three of four places by using a long slender open nozzle about 3/16 to ¼ inch in diameter, which insert into the different veins on the lower side of the livers. The brine should be forced into them until the pressure swells them up; after pumping them, lay them out on a rack for 24 hours in a cooler and allow the blood to ooze out of them. The pumping brine for beef livers is made the same as the brine for hog livers as follows:

1 lb. of **Freeze-Em-Pickle.**
12 lbs. of Common Salt.
5 gal. of Water.

The day after the livers have been pumped, they should be packed in a 60 deg. common salt brine, which is made by dissolving 15 lbs. of salt in 85 lbs. of water; nothing else need be added. All animal heat must be thoroughly extracted, and the livers must be properly chilled and cooled.

DIRECTIONS FOR CURING LEAN SHOULDER BUTTS.

LIGHT WEIGHT BUTTS.

Use for 100 lbs. Light Weight Butts.	5 lbs. of Common Salt, 1 lb. of **Freeze-Em-Pickle,** 2 lbs. Granulated Sugar, 5 gals. of Cold Water. Cure in this brine 20 to 30 days.

HEAVY WEIGHT BUTTS.

Use for 100 lbs. Heavy Weight Butts.	6 lbs. of Common Salt, 1 lb. of **Freeze-Em-Pickle,** 2 lbs. of Granulated Sugar, 5 gals. of Cold Water.

Cure in this brine from 30 to 40 days according to size.

The sugar used must be Pure Granulated Sugar; yellow or brown sugar must not be used.

First:—Sort the Butts, separating the Light Weight Butts and the Heavy Weight Butts.

Second:—Take enough of any one size of the assorted Butts to fill a tierce which will be 285 lbs.; then thoroughly mix together in a large pail or box the following proportions of **Freeze-Em-Pickle,** the very best and purest Granulated Sugar and Salt.

Use for 285 lbs. of Light Weight Butts, 3 lbs. of **Freeze-Em-Pickle,** 6 lbs. of Granulated Sugar and 15 lbs. of Salt.

For 285 lbs. of Heavy Weight Butts, 3 lbs. of **Freeze-Em-Pickle,** 6 lbs. of Granulated **Sugar** and 18 lbs. of Salt.

HOW TO CURE BUTTS IN OPEN TIERCES.

When the tierces or barrels in which these Butts are cured, are not to be headed up, but are left open, use half of the **Freeze-Em-Pickle,** Sugar and Salt for rubbing as follows:

First:—Rub each Butt well with some of the mixture of **Freeze-Em-Pickle,** Sugar and Salt. Sprinkle a little of the mixture in the bottom of the tierce.

Second:—Pack the Butts in a perfectly clean tierce. The mixed **Freeze-Em-Pickle,** Sugar and Salt that is left after rubbing should be used for making the brine. It will require 14 to 15 gallons of brine for each tierce of Butts. Make the brine by dissolving in

cold water all the mixed Freeze-Em-Pickle, Sugar and Salt that is left after the Butts are rubbed. Stir well for a minute until it is dissolved, and then pour this brine over the meat. When curing only a small quantity of Butts, cut down the proportions of Freeze-Em-Pickle, Sugar and Salt, also the quantity of water, according to the quantity of Butts to be cured.

QUANTITY OF BRINE TO USE FOR CURING 100 LBS. OF BUTTS.

Five gallons by measure, or 42 lbs. by weight, is the approximate amount of water to use for every 100 lbs. of meat.

Tierces, after being packed with 285 lbs. of meat, will hold about 15 gallons of water. When curing Butts in vats or open barrels, whether in small or large quantities, always use not less than 5 gallons of brine to 100 lbs. of meat, as this makes the proper strength and a sufficient brine to cover the meat.

HOW TO OVERHAUL BUTTS WHEN CURING IN OPEN PACKAGES.

On the fifth day after packing each lot of Butts, it is necessary that they should be overhauled. This must be repeated seven days later; again in ten days, and a final overhauling should be given ten days later. Overhauling Light Butts three times, and Heavy Butts four times while curing, and at the proper time in each instance, is very important, and must never be forgotten, especially when curing with this mild, sweet cure. Overhauling means, to take the Butts out of the brine and to repack them in the same brine. The proper way to overhaul is to take a perfectly clean tierce, set it next to the tierce of Butts to be overhauled, pack the meat into the empty tierce, and then put this same brine over the meat.

HOW TO CURE BUTTS IN CLOSED UP TIERCES.

Large packers who employ coopers, should always cure Butts in closed up tierces, as this is the best method known.

First:—Mix the proper poportions of **Freeze-Em-Pickle**, Sugar and Salt, for the different size Butts to be cured. These proportions are given in the foregoing table, under the heading, "Light Weight Butts, and Heavy Weight Butts." If the tierces are to be headed up, use half of the **Freeze-Em-Pickle**, Sugar and Salt, for rubbing the Butts, and the half that is left over after the Butts are rubbed, should be dissolved in the water which is to be used to fill the tierce. Rub each Butt well before packing; put only 285 lbs. of meat in each tierce, and then head them up.

Second:—Lay the tierces on their sides and fill them through the bung hole, with water in which the half of **Freeze-Em-Pickle**, Sugar and Salt left over after rubbing, has been dissolved.

Third:—Insert the bung and roll tne tierces. This will mix and dissolve the **Freeze-Em-Pickle**, Sugar and Salt rubbed on the meat. Where the pieces of meat press tightly against each other, or against the tierce, the brine does not act on the meat; but if the pieces of meat are rubbed properly with the mixture of **Freeze-Em-Pickle**, Sugar and Salt before being packed in the tierce, such surfaces will be acted upon by the undissolved mixture, so that the curing will be uniform and no portion of the pieces will be left insufficiently cured, even if the brine does not come in contact with it. For this reason, it is important that each piece of meat should be carefully rubbed with the mixture before being packed in the tierce.

Fourth:—Overhaul five days after packing; again seven days later, again in ten days, and once more ten days thereafter. At each overhauling, examine each tierce for leaks; if any of the Pickle has leaked out, knock the bung in and refill. Remember to overhaul Light Butts three times, and Heavy Butts four times.

Fifth:—Overhaul Butts in closed-up tierces, simply by rolling the tierces from one end of the cooler to the other. They ought to be rolled at least 100 feet.

ROLLED BONELESS BUTTS OR BUTT SAUSAGE.

After the Butts are thoroughly cured, they should be stuffed in beef bungs; if they are large only one should be stuffed in each casing; if they are small, two can be stuffed together side by side. The casings should be tied off at each end, and then wound with a heavy string, which should be wrapped as tightly as possible. Perforate the casings with a fork so as to let out any air that may be in them; then smoke them over night in a cool smoke; in the morning boil them. If they are to be sold uncooked, dip them in boiling water for five minutes, and then in cold water so as to shrink the casings. Our new Improved Zanzibar Carbon can be used on the casings to give them an appetizing color. See directions for dipping on page 2668.

HOW TO CURE MEAT FOR LUNCH HAM OR NEW ENGLAND STYLE PRESSED HAM

(ALSO CALLED BERLINER STYLE HAM)

The **Freeze-Em-Pickle** Process is especially adapted for curing Ham trimmings which are used for Berliner Style Hams, Lunch Hams, Boneless Hams, New England Style Pressed Hams, etc. It will cure and preserve Ham trimmings perfectly, and will give them a rich, delicate sugar-cured ham flavor. It does not draw the albumen out of the meat, but the natural binding qualities are retained, and the meat has a rich, red, cured-meat color. Trimmings cured with the **Freeze-Em-Pickle** Process can be kept in cold storage for a year without getting too salty or becoming short and losing their nice flavor and binding qualities.

The following directions must be carefully followed to get the results desired:

First:—The trimmings should not be larger than an egg, and should be

as uniform in size as possible.

Second:—Do not run the trimmings through an Enterprise Grinder to cut them up before packing them, as it has a tendency to heat the meat.

Third:—Trimmings that are to be held for any great length of time must be fresh as possible; if they should be somewhat slimy, they should be washed thoroughly in cold common salt brine and allowed to drain until quite dry. Never mix or salt trimmings that become slimy, with fresh ones; always pack them separately.

Fourth:—It is absolutely necessary that the meat should be thoroughly chilled, and that the packing should be done in the cooler so that the temperature of the meat will not get above the temperature in which it is to be cured.

Fifth:—For each 100 lbs. of trimmings, take 1 lb. of **Freeze-Em-Pickle**, 1 lb. of best Granulated Sugar and 2 lbs. of Common Salt, and mix these thoroughly with the meat. Mixing thoroughly is very important; it should be carefully done so as to insure a uniform cure.

Sixth:—Have the tierces or barrels perfectly clean and sweet; then sprinkle a little salt on the bottom, and fill the barrel or tierce about one-quarter full of salted meat, and pound it down hard with a tamper. Do the same when the barrel is half full and continue in this manner until the barrel is filled. This tamping is done to expel the air between the pieces of meat, and it is an important factor to insure a uniform cure and color. If the trimmings are to be kept any length of time, it will be necessary that the tierces or barrels should be headed up, and they should always be filled with meat as much as possible. When trimmings are to be used as soon as cured, it is not necessary to head them up, simply put a top on them and weight them down, or cover them with a clean cloth and put a layer of salt about one inch thick, over the top of the cloth. This will keep out the air and will give good results. The trimmings will be cured in from two to three weeks, and are then in a perfect condition to be made into New England Style Pressed Hams, etc. They need not be soaked in water, nor need any salt be added as they are ready for instant use just as they are and will have a delicious sugar-cured ham flavor.

See paragraph on Temperature for Curing Meats on page 2646.

HOW TO MAKE NEW ENGLAND STYLE PRESSED HAMS

After the meat is cured, it should be stuffed in beef bungs, and should be smoked about three hours, but this depends upon the smoke house and whether wood or sawdust is used. It may be necessary to smoke the Pressed Ham still longer. Boil them in a temperature of 180 degrees Fahrenheit for 1½ hours, then reduce the temperature to 170 degrees Fahrenheit and remove them at the expiration of one hour. After they are boiled for 2½ hours, they should be laid out on a table in the cooler, and then boards should be placed on top of them weighted down with heavy stones, and should remain there over night before being removed.

The casings may be given an appetizing smoke color by momentary dipping in a solution of Zanzibar-Carbon Brand Casing Brown Mixture (see page 2668 for directions)

HOW TO CURE MEAT FOR MAKING FINE BOLOGNA AND FRANKFURT SAUSAGE AND COMPLY WITH PURE FOOD LAWS

In following the old method of making Bologna and Frankfurt Sausage, a large percentage of the albumen is drawn out of the Meat, thus losing much of the richness, flavor and color which should be retained in the Sausage.

B. Heller & Co. have made an important improvement in the process of curing trimmings, and Sausage Makers will find it greatly to their advantage to make an immediate trial of this process. A single batch of Sausage made after this method will convince any Sausage Maker of the mistake of following the old ideas of making Bologna and Frankfurt Sausages.

When Bologna and Frankfurts are made from fresh Meats, they have a gray color and are very difficult to keep in good condition, especially during the warm weather. However, when Bologna and Frankfurts are made by the **Freeze-Em-Pickle** Process, they will have a fine red color and they will comply with the Pure Food Laws, because **Freeze-Em-Pickle** contains no ingredients which have been prohibited by any of the food laws. They will also keep much better than when made in the old way, and will stand shipment during the warm weather with better results.

HOW TO CURE BEEF OR PORK TRIMMINGS WITH FREEZE-EM-PICKLE

Trimmings that are to be stored away for a few days to two weeks, should be packed with the following proportions of Freeze-Em-Pickle and Salt.

To every 100 lbs. of Trimmings use the following:
1 lb. of Freeze-Em-Pickle.
1 lb. of Salt.

For Trimmings that are to be stored away for two weeks to three months, the following proportions of **Freeze-Em-Pickle** and Salt should be used:
1¼ lbs. of **Freeze-Em-Pickle** and
1 lb. of Salt to each
100 lbs. of Trimmings.

For Trimmings that are to be stored away for three months to six months, the following proportions of **Freeze-Em-Pickle** and Salt should be used:
1½ lbs. of **Freeze-Em-Pickle** and
1 lb. of Salt to each
100 lbs. of Trimmings.

First:—Weigh the Trimmings and then spread them on

a table.

Second:—Weigh out the proper proportions of **Freeze-Em-Pickle** and Salt, mix them together thoroughly, and then sprinkle over the meat.

Third:—Mix the Trimmings well so that the Salt and **Freeze-Em-Pickle** get to all parts of the meat.

Fourth:—Run the Trimmings through the grinder, using what is called the lard plate, a plate that has holes in it from 1 to 1¼ inches in diameter. By first mixing the **Freeze-Em-Pickle** and Salt with the meat and then putting it through the grinder, the **Freeze-Em-Pickle** and Salt become better mixed with the meat.

Another way is to run the Trimmings through the grinder first, using the lard plate with 1 to 1¼ inch holes in it; then put this meat in the mixer and while mixing add the **Freeze-Em-Pickle** and Salt, which have first been thoroughly mixed. Let the mixer run until the **Freeze-Em-Pickle** and Salt are thoroughly mixed with the meat, which only takes a few minutes.

If a plate with large holes in it is not available, cut the Trimmings up small by hand and then mix the **Freeze-Em-Pickle** and Salt with the meat.

HOW TO PACK IN BARRELS OR TIERCES

First:—Take barrels or tierces that are perfectly clean and sweet; this is very important. Then sprinkle a handful of **Freeze-Em-Pickle** and **Salt** which have first been thoroughly mixed, over the bottom of the tierce.

Second:—Fill tierce about one-quarter full of the meat that has been mixed with **Freeze-Em-Pickle** and Salt, and then with a tamper, tamp it down as tight as can be. The tighter the meat is packed, the better. Then place more of the meat into the tierce and tamp it, and keep on doing this until the tierce is full.

Third:—If the tierce is not to be headed up, don't fill it quite to the top, and after tamping the meat tight, sprinkle a couple of handfuls of the mixture of **Freeze-Em-Pickle** and Salt over the top. Then lay a piece of parchment paper over the meat, and on top of this place a piece of cheese cloth about a yard square.

Fourth:—On top of the cheese cloth put about two or three inches of dry Salt, spread so it reaches to all the edges of the barrel, so as to exclude the air from the meat, and then turn the ends of the cloth over the top, and allow this meat to stay in the cooler until you are ready to make Bologna, Frankfurts, or any similar sausage out of it.

This meat is now ready in four or five days to be made into Bologna, Frankfurts, or any similar sausage, but can also remain in a cooler as long as six months or even longer without being disturbed. This meat will not become too salty no matter how long it stands, and whenever you wish to make Bologna, Frankfurts, or any similar sausage, the meat is ready to be used.

This is known as the **Freeze-Em-Pickle Process**, and by curing the meat in this way no brine or albumen will be found at the bottom of the tierce when the meat is taken out. The meat when taken from the barrel will be found sticky, and to possess good binding quality and a nice cured flavor. It will make delicious Bologna, Frankfurts, or any similar sausage. The meat will have a nice sweet cure and a fine color which will be imparted to the Bologna, Frankfurts or any similar sausage made from it. On account of the meat being cured, the Bologna, Frankfurts and other sausage will not spoil so easily as they would if made from fresh meat.

Beef or pork trimmings should be handled in the same way, and no fresh meat used at all in making the Bologna or Frankfurts.

If the trimmings are to be kept for any length of time, it is advisable to head them up. When tierces are to be headed up, fill them as full as possible, sprinkle two handfuls of **Freeze-Em-Pickle** and salt, which have first been thoroughly mixed, over the top and then put on the head.

When making this **Freeze-Em-Pickle** cured meat into smoked sausages, more salt of course must be added, as the meat is not sufficiently salty, so when adding the Seasoning add sufficient salt to give it the proper taste, and add ½ lb. of sugar to every 100 lbs. of meat in addition to the spice, as it gives the meat a delicious flavor.

PROPER TEMPERATURE FOR STORING TRIMMINGS

If the trimmings are to be used up in two or three weeks, any ordinary cooler that is kept around 40 degrees will be sufficient, but if trimmings are to be kept three to six months, they should be kept in a cooler at a temperature of 35 to 36 degrees to get the best results. Never let the temperature get down below freezing if it can be helped, and do not let it get any higher than 38 degrees, if possible.

HOW TO MAKE BOLOGNA AND FRANKFURTS FROM FRESH BEEF AND PORK WITH FREEZE-EM-PICKLE WITHOUT FIRST CURING THE MEAT

Run the desired quantity of beef and pork through a grinder, first using a coarse plate, then through a fine one; then finish in a silent chopper. While cutting it in the silent cutter, add to each 100 lbs. of meat 1 lb. of **Freeze-Em-Pickle**, ¼ lb. of "B" Condimentine, 1 to 1½ lbs. of salt and ½ lb. of sugar, according to taste. Chop this up as usual, adding pure artificial ice to keep it cool. First put the beef in the silent cutter and when it is about three-fourths fine add the necessary pork, which has first been run through the ¼ inch plate of a grinder. If a mixer is not used, add the Seasonings and flour to the meat in the silent cutter. When all are thoroughly mixed put into a tub, cover well over with parchment or wax paper to exclude the air and put away until ready to use. The meat can then be taken direct from the tub in 24 to 36 hours, placed into the stuffer, and stuffed into the casings.

The meat should be kept in a temperature of 45 to 46 degrees. This is a fairly high temperature which gives the **Freeze-Em-Pickle** a chance to do its work quicker, and by standing 24 to 36 hours after it is chopped and seasoned, it develops its full binding qualities and saves handling the meat two or three times, which should appeal to every sausage maker.

FORMULA FOR BOLOGNA SAUSAGE

The following formula makes very fine Bologna sausage:

75 lbs. beef trimmings cured by Freeze-Em-Pickle Process.

15 lbs. pork trimmings cured by Freeze-Em-Pickle Process.

10 lbs. pork speck (back fat).

Bull-Meat-Brand Sausage Binder in the percentage amount of cereal allowed by your State Food Law, but not over five pounds to the hundred.

8 to 10 ounces Zanzibar-Brand Bologna Sausage Flavor.

¼ lb. "B" Condimentine

Sufficient cracked ice for cooling.

First:—Salt the pork and beef trimmings according to the directions on foregoing pages.

Second:—When making the Bologna (or Frankforts), take the beef that has been cured with Freeze-Em-Pickle and run through the grinder, using ¼ or ⅜ inch plate. (Some sausage makers prefer to run this meat through the grinder again, using the smallest plate they have, but this in our opinion takes up unnecessary time and labor. Once running through a ¼ or ⅜ inch plate is sufficient).

Then place this beef in the silent chopper. As soon as this has made one or two revolutions, put in sufficient cracked ice to prevent the beef from becoming heated. Then add about one pound of salt; adding ice if necessary. Then add the pork to the beef, which should have already been run through the grinder, and at the same time add the pork speck.

Third:—Then for seasoning add 8 to 10 ounces Zanzibar-Brand Bologna Flavor, and also about ¾ of a pound of "B" Condimentine. This Condimental preparation is permissible in all Government inspected houses and complies with the Pure Food Laws. "B" Condimentine is used to prevent shrinkage and help keep the sausage, and so the color inside will not fade or turn gray, but retain its bright, rich color for ten days if kept under proper conditions. This is a great advantage, especially to large packers who do shipping. After the Spices and Condimentine are worked in, then add salt to taste. Sausage made with "B" Condimentine does not have to be labeled that a preservative is used.

Fourth:—Then while the meat is being cut in the silent chopper, add the legal amount of Bull-Meat-Brand Sausage Binder to each 100 pounds of meat. Or, if a mixer is used, add the binder in the mixer. When properly mixed and seasoned with spices and "B" Condimentine, and binder has been added, it is already for the stuffer, or if desired, this meat already chopped can be kept in tubs in a cooler of a temperature of 38 to 40 degrees for 24 to 36 hours until required.

Notice:—See our instructions on page 2669 for handling beef that has been cured with Freeze-Em-Pickle and stored away from two to six months or longer.

Note:—Since the Pure Food Laws have been enacted, all Antiseptic Preservatives have been ruled out and cannot be used in sausage, so sausage makers must be careful what kind of a Sausage Binder they use in their sausage. Many of the binders on the market start fermentation soon after moisture is added to them. When it is noticed that Bologna does not keep as well as it should, the first thing to be looked to is the binder used, as invariably a binder which is not free from the germs of fermentation will cause trouble, and the losses a butcher has from using such binders will amount to more than the saving in the cost of the binder. Many cheap binders can be bought for less money than Bull-Meat-Brand Sausage Binder, as they cost less to manufacture. We are not trying to see how cheap a binder we can manufacture, but our sole aim in selling Bull-Meat-Brand Sausage Binder is to offer the very Finest Binder that we know how to make, which will help the sausage instead of souring it, and, even if our price is a trifle higher, Bull-Meat-Brand Sausage Binder is much cheaper to use and results are always satisfactory.

Notice:—**If a Garlic flavor is desired, add one or two tablespoonfuls of Vacuum-Brand Garlic Compound while the meat is being chopped. Vacuum-Brand Garlic Compound is recommended as it does not sour in the sausage and it does not leave any after-taste nor taint the breath, because it is so finely divided that it is thoroughly incorporated in the meats and is thoroughly digested and absorbed. In States where Cereal is not permitted, use Garlic Condiment instead of Garlic Compound.**

Fifth—After the meat is chopped to the proper fineness, stuff it into beef rounds or beef middles. Place the sausage in the smoke house and smoke.

BOILING BOLOGNA.

After it is smoked, boil Round Bologna 30 minutes in water 160 degrees Fahrenheit and Long Bologna for 45 to 60 minutes in 160 degrees water, according to thickness.

After they are boiled place them on a table, or hang them up and pour boiling water over them to wash off the grease. Then pour cold water over them to shrink the casings. After that allow them to cool in the open air or a well ventilated room, before placing in the cooler or ice box. **This will prevent sweating, which causes mouldy and slimy casings.**

BOILING LARGE BOLOGNA.

If Large Bologna are desired, stuff the meat into beef bungs and smoke until they are nicely smoked, then boil them from 1¼ to 1½ hours in water 155 degrees Fahrenheit. Vary the time of boiling according to the thickness of the Bologna.

SALTING FAT FOR BOLOGNA.

The Pork Back Fat or Pork Speck will be much better for use in Bologna and Frankforts if it is dry salted with Freeze-Em-Pickle for a few weeks before it is used.

HOW TO COLOR THE CASINGS OF SMOKED SAUSAGE WITH ZANZIBAR-CARBON BRAND CASING BROWN MIXTURE

COLORING BOLOGNA CASINGS

Hang the bologna in the smoke house just long enough to dry the skin well, or hang it in front of a hot fire, or in the sun, any way to get the excess moisture dried out of the casing; then proceed according to the following method:

METHOD OF COLORING THE CASINGS OF SAUSAGE IN GOVERNMENT INSPECTED PACKING HOUSES

In all Packing Houses having U. S. Government inspection, the coloring of casings are allowed only by what is

termed "Momentary Dipping". We advise butchers to use this method in preference to any other way whether they have Government inspection or not.

Directions for Momentarily Dipping Smoked Sausage such as Bologna, Frankfurt, etc.

After Sausage has been smoked and cooked, dip it into a solution made up in the proportion of 1 ounce of Zanzibar-Carbon-Brand Casing Brown Mixture to every 20 gallons of water. Always dissolve it first in some hot water (not boiling) in the proportion of one-half gallon water for every ounce used and then pour this solution into the balance of the water to make up the dipping solution.

The water used for dipping should be about the same temperature as that in which the Sausage is cooked. After dipping, the Sausage must be rinsed off with hot water and thereafter with cold water, then hung up in the usual manner to drip off and dry. When Sausage is smoked through and is not cooked, it must be well sprayed with, or dipped into, boiling hot water to remove the grease from the casing before being put into the colored dipping solution.

FRANKFORT SAUSAGE; HOW TO MAKE

Frankfort Sausage is made in most cases in exactly the same manner as Bologna with the exception that it is chopped very fine and Zanzibar-Brand Frankfort Sausage Seasoning is used. To make fine Frankfort Sausage use two parts of Beef and one part of Pork.

If Veal is used in Frankfort Sausage, it improves it considerably, but the price of Veal is so high that it is very seldom used. Stuff in sheep casings and smoke lightly, then dip them in Zanzibar-Carbon Brand Casing Brown Mixture by the method prescribed on the preceding page.

Dipping them in hot water and then in cold takes out all the wrinkles. After they have been dipped, pour a pail of hot water over them to wash off all adhering grease; then dip them for a minute or two in ice water to cool. This will make them contract so rapidly that they will not wrinkle; then put in a cooler to hang up and cool through to the center.

COLORING FRANKFURT SAUSAGE CASINGS

Follow the directions given above for momentary dipping.

If a deep color is desired, slightly increase the amount of Zanzibar-Carbon Brand Mixture. You must use your own judgment in producing the right color desired, as the drier the casing the less Zanzibar-Carbon Brand Mixture it takes and the better the color will be.

Always be particular not to smoke with too much heat in the smoke house, so that the grease does not melt in the sausage and come through the casing.

CURING BEEF CHEEKS FOR BOLOGNA AND FRANKFURTS

First:—The Cheek Meat should be cut out of the heads as soon as possible after the beef is killed, and the gristle should be cut through lengthwise, two or three times. All the fat can also be trimmed off or left on, just as desired; in a large slaughtering establishment, the fat is worth more in the tank than in the sausage.

Second:—The Cheeks should then be thrown into ice water and allowed to remain there for an hour or two. This will draw out all the slime and blood.

Third:—The Cheeks should then be spread out thinly on coarse wire screens, or on perforated galvanized iron pans, in a cooler. They should be spread out as thinly as possible so as to thoroughly drain and chill.

Fourth:—After they are thoroughly chilled, which will take 24 hours, they should be salted as follows:

DIRECTIONS FOR DRY SALTING BEEF AND PORK CHEEK MEAT

Beef and Pork Cheek Meat that is to be stored away for a few days to two weeks, should be packed with the following proportions of **Freeze-Em-Pickle** and salt.

To every 100 lbs. of Beef and Pork Cheek Meat use the following:

1 lb. of **Freeze-Em-Pickle.**
1 lb. of Salt.

For Beef and Pork Cheek Meat that is to be stored away for two weeks to three months, the following proportions of **Freeze-Em-Pickle** and salt should be used:

1¼ lbs. of **Freeze-Em-Pickle** and
1 lb. of Salt to each
100 lbs. of Beef and Pork Cheek Meat.

For Beef and Pork Cheek Meat that is to be stored away for three months to six months, the following proportions of Freeze-Em-Pickle and salt should be used:

1½ lbs. of **Freeze-Em-Pickle** and
1 lb. of Salt to each
100 lbs. of Beef and Pork Cheek Meat.

First:—Weigh the Beef and Pork Cheek Meat and then spread it on a table.

Second:—Weigh out the proper proportions of **Freeze-Em-Pickle** and salt, mix them together thoroughly, and then sprinkle over the meat.

Third:—Mix the Beef and Pork Cheek Meat well so that the salt and **Freeze-Em-Pickle** get to all parts of the meat.

Fourth:—Run the Beef and Pork Cheek Meat through the grinder, using what is called the lard plate, a plate that has holes in it from 1 to 1¼ inches in diameter. By first mixing the **Freeze-Em-Pickle** and salt with the meat and then putting it through the grinder, the **Freeze-Em-Pickle** and salt become better mixed with the meat.

Another way is to run the Beef and Pork Cheek Meat through the grinder first, using the lard plate with 1 to 1¼ inch holes in it; then put this meat in the mixer and while

mixing add the **Freeze-Em-Pickle** and salt, which have first been thoroughly mixed. Let the mixer run until the **Freeze-Em-Pickle** and salt become thoroughly mixed with the meat, which only takes a few minutes.

If a plate with large holes in it is not available, cut the Beef and Pork Cheek Meat up small by hand and then mix the **Freeze-Em-Pickle** and salt with the meat.

Fifth:—If the tierces are to remain open, they can be covered with a clean cloth and a layer about two or three inches thick of dry salt should be put over the top of the cloth. This will exclude the air and keep the top meat from getting dry and dark.

Sixth:—Cheek Meat that has been properly chilled and packed in this manner can be kept for any length of time and need not be overhauled. It can be kept for a year or longer and whenever it is taken out of the barrel and used, it will make fine Bologna and Frankforts with a fine color and a delicious flavor. Dry salted Cheek Meat makes much better Bologna than the pickled Cheek Meat. Sometimes Cheeks are very low in price, and they can be packed and stored as above directed and kept until the market advances; by this method quite a sum of money can be made each year.

Seventh:—See paragraph on Temperature for Curing Meats on page 2646.

CURING BEEF AND PORK HEARTS FOR BOLOGNA AND OTHER SAUSAGE.

First:—As soon as the beef or hog is slaughtered, the hearts should be cut open; the pork hearts should be cut into four squares, and the beef hearts into six or eight pieces, being sure to cut them so that all the crevices are open and exposed. They should then be placed in ice water in which they should be allowed to remain for two to three hours.

Second:—Spread the hearts on trays or racks in a cooler as thinly as possible, and allow them to drain and chill for 24 hours; they must be thoroughly chilled so that all animal heat leaves them.

Use for 100 lbs. of Beef or Pork Hearts.	1¼ lbs. Freeze-Em-Pickle. 1 lb. of Common Salt.

Third:—Run hearts through an Enterprise grinder, using a lard plate with 1½-inch holes; then place in a mixer and gradually add the mixture of Freeze-Em-Pickle and salt. Be sure it is evenly divided and thoroughly mixed.

Fourth:—Take a perfectly clean tierce, and sprinkle a handful of salt, and a little Freeze-Em-Pickle on the bottom; put the salted hearts into the tierce and tamp them down with a tamper as hard as possible.

The object in tamping with a tamper is to get all the air out and to close up all the cavities in the barrel. The less air cells in the barrel, the better the hearts will cure and keep.

Fifth:—If the tierces are to be headed up, sprinkle a handful of salt on top of the tierces, cover nicely with a piece of parchment paper and put in the heads, being careful that the tierces are as full as they possibly can be before the heads are put in, and also that the tierces are perfectly sweet before packing.

Sixth:—If the tierces are to remain open, they can be covered with a cloth and about two or three inches of dry salt should be put over the top of the cloth. This will exclude the air, and will keep the top meat from getting dry and dark.

Seventh:—Hearts that have been properly chilled and packed in this manner can be kept for any length of time and need not be overhauled. They can be kept for a year or longer, and whenever taken out of the tierces to use, they will make fine bologna and such sausage as hearts can be used for. Quite a quantity of properly cured hearts can be used in the manufacture of sausage with very good results. They will have a fine color and a delicious flavor. Hearts should never be pickled for Bologna, but should always be dry salted as above directed. It is very often the case that hearts can be bought at a small cost when the market is low, and if so purchased and packed and stored as herein directed until the market advances and meat is high, they can be made into bologna with a very handsome profit.

Eighth:—See paragraph on Temperature for Curing Meats on page 2646.

GERMAN STYLE HAM SAUSAGE

German Style Ham Sausage is made very much like Bologna, except that the meat should be chopped finer. For every 100 lbs. of Ham Sausage, take the following:

50 lbs. of Pork Trimmings.

40 lbs. of Beef Trimmings.

5 lbs. of Pork Speck (Back Fat).

Bull-Meat-Brand Sausage Binder in the percentage proportion of cereal allowed by your State Food Law.

¾ lb. "B" Condimentine.

2 lbs. of Salt.

6 to 8 ounces Zanzibar-Brand Frankfort Flavor.

First:—Salt the Pork and Beef Trimmings four or five days ahead, using to each 100 lbs. of meat 1 lb. of **Freeze-Em-Pickle**, as directed on page 2666. No salt or anything in addition to the **Freeze-Em-Pickle** should be added when the meat is put down to cure. The salt is added when the Sausage is made.

Second:—When making Ham Sausage, use the Pork and Beef in the proportions as stated above and when about half chopped add the Speck or Back Fat.

Third:—After adding the Fat, add sufficient salt so as to have 2 lbs. to each 100 lbs. of finished Ham Sausage. Also

add 6 to 8 ounces Frankfort Flavor.

Fourth:—Now proceed to chop or grind the meat according to directions given on page 82, using cracked ice to keep the meat cool.

Fifth:—When the meat is chopped, stuff it into Beef Bung Casings. After the Sausage is stuffed, it is well to wrap string around it tight, so the Sausage will be firm when cooked and will not drop in the smoke house.

Sixth:—Smoke this sausage carefully over a medium warm fire.

Seventh:—Cook the Sausage from 1¼ to 1½ hours, in water 155 degrees hot. Vary the time according to the thickness of the Sausage. See directions on page 83 for coloring Bologna casings and color the casings of this Sausage the same way.

Eighth:—After Sausage of any kind has been cooked, it should be handled as follows: Pour boiling water over it to wash off the surplus grease that adheres to the casings and then pour cold water over it to shrink and close the pores of the casings. This is very important and it should be closely observed by all packers and sausage makers who wish to have their Sausage look nice and fresh in appearance.

HOW TO PREPARE CASINGS BEFORE STUFFING.

Before casings are stuffed, they should always be soaked in warm water, so as to make them pliable, so they will stretch to their utmost limit when being stuffed. If they are properly soaked, they will stretch considerably and will not burst as easy as they will if they are not properly soaked. The casings should be soaked in water about 90 degrees temperature Fahrenheit, from one to two hours, depending upon how old and dry they are. If the casings are very old and dry, they will have to be soaked until they are perfectly soft and pliable. When casings are soaked in water that is too hot, the casings are scalded and become tender and will burst when being stuffed, and the heavy Sausage will tear loose in the smoke house.

HOW TO PREVENT BURSTING AND SHRINKING OF SAUSAGE.

Many undergo a great deal of trouble from the bursting and shrinking of Sausage and it is a trouble which can be easily avoided, as it is entirely owing to the manner of boiling the Sausage. Ordinary round or long Bologna should be kept in water at 160 to 170 degrees Fahrenheit for about 30 minutes, and thick large Bologna should be kept in water from 155 to 160 degrees Fahrenheit from three-quarters of an hour to one hour, according to the size. If the Sausage is very large, it will take from one and one-quarter to one and one-half hours to cook them thoroughly. When Sausage is boiled in water that is too hot the particles of meat will crumble and separate. The Sausage will taste dry, although water will be in the crevices between the small pieces of meat. The Sausage will look rough on the outside and will also lose more weight than when boiled as above directed. Many of them will burst when the water is too hot. After Sausage of any kind has been cooked, it should be handled as follows: Pour boiling water over it to wash off all the surplus grease that adheres to the casing and then pour cold water over it to shrink and close the pores of the casing. This is very important and should be closely observed by all packers and sausage makers who wish to have their Sausage look nice and keep its fresh appearance.

HOW TO SEASON HAMBURGER SO AS TO MAKE IT MORE PALATABLE AND PLEASING.

A very successful way of increasing trade on Hamburger is to season it with one ounce of Zanzibar-Brand Hamburger Seasoning to every 25 pounds of meat. This gives the meat a Delicious Flavor, makes it more Palatable and Pleasing to the Taste and much more Appetizing and Satisfactory to the Customer. Sometimes Hamburger when made without Seasoning has a peculiar flavor and meat odor which many customers object to.

All this trouble is overcome by Seasoning all Hamburger with our Zanzibar Brand Hamburger Seasoning, as it gives the meat a Delicious Flavor and Aroma.

This is something that will increase the sale on Hamburger wherever it is used.

HAMBURGER SAUSAGE

Below we give the recipe for a New Sausage that is well liked where-ever it is being tried, and we advise every butcher to make use of it. This Sausage is a success, takes well with the trade when made up right and is very easy to make. It is a nice eating Sausage and customers are always pleased to get hold of something new for a change. Making Hamburger Sausage gives the butcher an opportunity for selling all the small pieces of beef and a large percentage of beef fat at a good profit, which is very often not easily sold otherwise.

DIRECTIONS FOR MAKING HAMBURGER SAUSAGE.

Take—

70 lbs. Beef Trimmings.

20 lbs. Beef Fat.

Bull-Meat-Brand Sausage Binder in the percentage proportion of cereal allowed by your State Food Law.

20 lbs. Water.

6 to 8 ozs. Zanzibar Brand Hamburger Seasoning.

1 lb. Freeze-Em-Pickle.

2 or 3 large size Onions.

2 lbs. Salt.

First:—Take the 70 lbs. of Beef Trimmings and trim out all the sinew and cut them into small pieces.

Second:—Spread the meat on a table and sprinkle over it 1 lb. of **Freeze-Em-Pickle** to 70 lbs. meat. Mix it thoroughly so that the **Freeze-Em-Pickle** gets to all parts of the meat and then run the meat through a sausage grinder, through a medium fine plate, so as to cut the meat into small pieces, so that the **Freeze-Em-Pickle** is thoroughly mixed with the meat. Then place it in the cooler in tubs or boxes not deeper than six inches and allow it to remain there from one to two days to cure. It is better to allow the meat to cure for two days or longer.

Third:—After the Beef is cured take 20 lbs. of Suet or Beef Fat, from the Brisket is the best, cut it up with 2 or 3 large Onions and run the Beef Fat and Onions through the meat grinder and grind it very fine, then mix the ground Beef Fat with the 70 lbs. of Cured Beef.

Fourth:—Put Legal amount of Bull-Meat-Brand Sausage Binder, 6 to 8 ozs. Zanzibar-Brand Hamburger Seasoning and 2 lbs. of Salt in a pail and add 20 lbs. of cold water. After mixing, add this to the ground Beef and Suet.

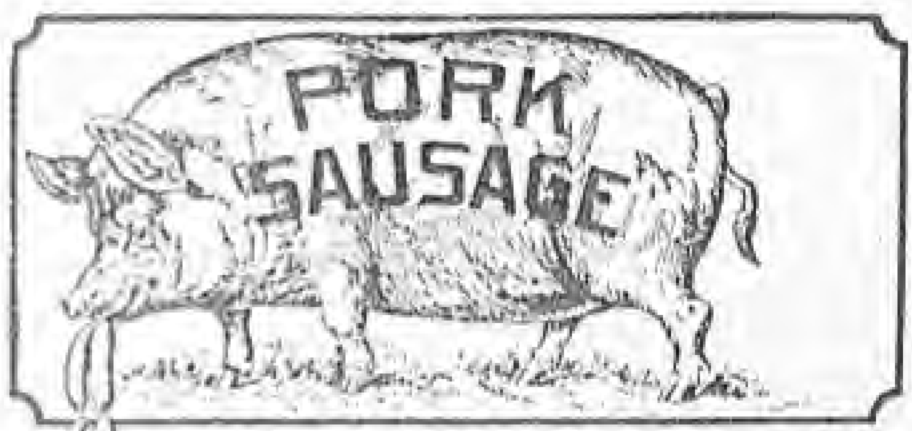
Fifth: — Mix the Beef, Suet, Bull-Meat-Brand Sausage Binder, Seasoning, Salt and water together as well as possible and then run it through the meat grinder again.

Notice: —Hamburger Sausage can also be made without curing the meat in advance, if one prefers.

Simply mix the Beef, Fat, Bull-Meat-Brand Sausage Binder, Hamburger Seasoning, Finely Cut-Up Onions, **Freeze-Em-Pickle** and Salt all together, run it through a Grinder and add the water while grinding and mixing, and when ground it is ready for sale. This sausage will, however, have a different flavor than when made of cured meat as above.

Sixth:—After the Sausage is ground, spread it out on a platter, decorate it nicely with parsley, a few pieces of sliced lemon or orange, which adds to its attractiveness.

With each can of Hamburger Seasoning we furnish some of these cards free. Take a beef skewer, split the end of it so the card can be put into the slit and then stick this skewer into the platter of Hamburger Sausage. This little card will help the sale and you will be surprised at the many compliments you will receive on this new Sausage. We will gladly furnish as many as are desired of these cards free of charge to any butcher who is using our Hamburger Seasoning.



DIRECTIONS FOR MAKING FRESH PORK SAUSAGE

Take 100 lbs. of Fresh Pork Trimmings and while chopping add

Bull-Meat-Brand Sausage Binder in the percentage proportion of cereal allowed by your State Pure Food Law.

¾ to 1 lb. "A" Condimentine.

1 lb. Salt.

8 to 10 ounces Zanzibar-Brand Pork Flavor.

Use sufficient cracked ice to keep the mixture cold. This will make a most delicious pork sausage.

When this is properly mixed it is ready for the stuffer. Pork Sausage should be stuffed into hog casings, or it may be simply put up in bulk.

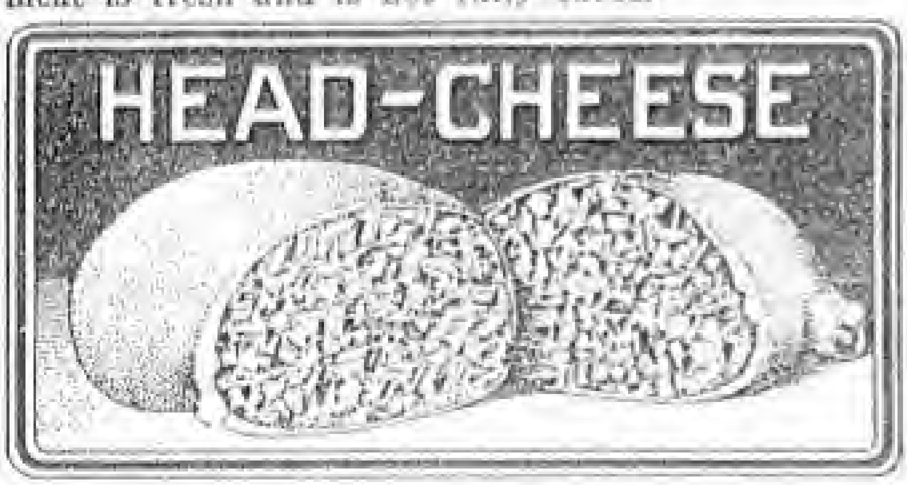
Note:—By using the above quantity of "A" Condimentine to each 100 lbs. of trimmings, it will prevent fresh pork sausage from turning sour or gray for several days, if kept under proper conditions and at a low temperature. It keeps the pork sausage in a firm, fresh condition. "A" Condimentine does not alter or affect the color of the sausage meat, but simply enables the meat to retain its own natural color. The use of this harmless condimental preparation is a great advantage to all packers and sausage manufacturers, especially when the sausage is shipped distances or is delivered from wagons to the small retailers. "A" Condimentine is guaranteed to comply with the Pure Food Laws and the Federal Meat Inspection Law. Its use is permitted in all U. S. Government Inspected Packing Houses. Sausage does not have to be labeled

to show the presence of a preservative when "A" Condimentine is used.

There are many kinds of Flours and Binders on the market, but the Sausage Maker will find Bull-Meat-Brand Sausage Binder to be thoroughly reliable, especially for Pork Sausage, as it does not so easily sour or ferment and it makes an emulsion of the fat and water, and when the Sausage is fried the grease and meat juices will not fry out of it readily, but will remain in the Sausage. Pork Sausage made with Bull-Meat-Brand Sausage Binder is much more easily digested than when made without it, because the fat goes into the stomach in the form of an emulsion when it is eaten, and in this way is more easily digested and absorbed. In using a Binder for Sausage, if it is the Butcher's desire to turn out a Fine-Flavored Sausage and one that is juicy when eaten, it is very important that he be very careful what kind of a Binder he uses. There are many Binders on the market, sold simply for the purpose of making money, which are *utterly worthless*. They make the Sausage dry and instead of improving the quality of the Sausage, they are a great detriment to it. If the Butcher takes a pride in his goods and wants to make Sausage that his trade will like, he should not buy these Binders, as he is simply throwing his money away and spoiling his goods by using them. Therefore, it is always advisable when buying from jobbers to insist upon getting the *Genuine B. Heller & Co.'s Bull-Meat-Brand Flour*, as you will then know exactly what you are getting, as our guaranty is on every package.

SMOKED PORK SAUSAGE

Pork Sausage not sold the day it is made may be smoked the following day and sold for Smoked Pork Sausage. Pork Sausage smoked the day after it is made will keep much better than when they are smoked as soon as made, because Sausage that have been kept in a cooler for 24 hours after being made are thoroughly cured, so they will stand the heat of the smoke house, and will have an entirely different flavor than if they are subjected to the heat when the meat is fresh and is not fully cured.



HOW TO CURE MEAT FOR HEAD CHEESE.

The proper way to make Head Cheese is to make it from Cured Meat only, and all the Heads and Meat used for it should be cured for 10 to 14 days in a brine made as follows:

1 lb. Freeze-Em-Pickle.
7 lbs. of Salt.
5 gals. Water.

Head Cheese made from Meat cured by this process will have a fine red color and will keep well under proper conditions in warm weather. Always add Bull-Meat-Brand Sausage Binder to Head Cheese, as it makes it firm and combines with the fats and juices of the meat, so as to keep the Head Cheese from drying out and thereby losing its flavor.

DIRECTIONS FOR MAKING HEAD CHEESE.

The proper meat to use for making Head Cheese is that which has been cured by the **Freeze-Em-Pickle Process**, as above described, but it can also be made from fresh meat if desired. It will, however, be much better and will keep for a longer time if made from meat cured by the **Freeze-Em-Pickle Process.**

First:—Boil the Heads slowly, and long enough so that the meat can be easily stripped from the bone.

Second:—Boil the Hog Rinds and the Hog Fat in nets at the same time as when boiling the heads. When the Rinds are almost cooked through, remove them from the kettle and chop or grind them fine. The Fat when cooked, should be cut up into 1¼ to 1½ inch square blocks.

Third:—Also boil about 15 lbs. of Cured Hog Tongues, and when they are cooked, cut them in strips.

Fourth:—The proper proportions for making good Head Cheese are as follows, but, the quantity of the different kinds of meat can be varied according to the stock on hand:

10 lbs. of Fresh Hog Back Fat.
15 lbs. of Cured Hog Tongues.
25 lbs. of Hog Rinds.
60 lbs. Cured Hog Head Meat (after removal from bone).
Bull-Meat-Brand Sausage Binder in proportion as allowed of cereal by your State Pure Food Law, but not over 5 pounds.
1 lb. of "A" Condimentine.
1 lb. of White Berliner Brand Konservirung Salt.

If any salt is needed add sufficient to suit the taste. If the meat is fully cured, no salt need be added.

Fifth:—The 60 lbs. of Head Meat must be cut into small pieces ½ to ¾ inch in size, either by hand or by machine.

Sixth:—The Rinds must be cut fine; the finer the better.

Seventh:—The Tongues must be cut into strips. The more Tongues used, the better will be the Head Cheese.

Eighth:—Mix thoroughly together the Tongues, Rinds, Head Meat, Bull-Meat-Brand Sausage Binder, the Prepared Head Cheese Seasoning and 1 lb. "A" Condimentine. At the same time mix into the Meat as much of the Water in which the meat was boiled as the Meat will absorb while being mixed. This water, in which the Heads have been cooked, contains Gelatine which has been drawn out of the meat while boiling, and this water congeals like Jelly when it becomes cold. The more of this water put into Head Cheese the better it will be, therefore add all of it that the meat will absorb. Bull-Meat-Brand Sausage Binder, in the proportion given in the above formula, will make a

very different Head Cheese from what can be made with some of the other Binders on the market. It will pay sausage makers to use B. Heller & Co.'s Genuine Bull-Meat-Brand Sausage Binder instead of any of the imitations now on the market. None of the other Binders that we have tested in our laboratory will prove as satisfactory as Bull-Meat-Brand Sausage Binder. If the Butcher uses the best of ingredients and follows the proper methods, he is bound to make the best products; but the most careful sausage maker cannot make fine products unless he uses **good material**.

Ninth:—After the Head Cheese Meat, Bull-Meat-Brand Sausage Binder and water in which the Heads have been boiled are mixed as above directed, stuff in Beef Bungs or Hog Stomachs and boil in water 155 degrees hot until they are cooked through. This will require from one to one and one-half hours, depeading upon the thickness.

Tenth:—When cooked, remove from the kettle and place in cold water until they are partly cooled; then lay them on boards and press them down by putting boards over the Head Cheese with weights on them. Head Cheese is sometimes smoked after it is pressed.

Eleventh:—If they are not smoked, rub them with White Berliner Brand Konservirung Salt in order to prevent them from getting slimy.

CURING MEATS FOR LIVER SAUSAGE.

Good Liver Sausage should always contain a certain amount of Meat and Fat in addition to the Liver. This Fat and Meat should be cured for a week or two, before making the Sausage, in a brine made as follows:

1 lb. Freeze-Em-Pickle.
7 lbs. Salt.
5 gals. of Water.

Liver Sausage made from Meat which has been cured in this manner will keep much better after it is made. Where it is necessary to ship Liver Sausage any great distance, or to keep it on hand any length of time after it has been made, the Livers should also be cured in the above brine for two weeks before making the Sausage. The best way to cure the Livers for this purpose is to cut them into strips after they have been chilled for 24 hours and then put them into the brine to cure. Packers who must ship Liver Sausage during the summer months will find the above directions in making Liver Sausage very valuable.

DIRECTIONS FOR MAKING LIVER SAUSAGE.

Take 70 lbs. of Hog Livers, 25 lbs. of Pork Necks; the entire Boned Head can be used instead of the Necks, or the trimmings which are cut from Bellies will work into Liver Sausage very nicely.

First:—Scald the Livers by pouring boiling hot water over them or dip them into boiling water until they are scalded through to the center. Then throw them into the ice water or put them into a tub of cold water and allow the water to run into the tub until the Livers are cooled through to the center, otherwise, they might sour in a short time.

Second:—Cook the Hog Necks, Heads or Bellies and remove all the meat from the bone.

Third:—Chop the meat as fine as possible. When an Enterprise Grinder is used, grind the meat as fine as it can be ground through a fine plate; then add the Livers, which have also been ground as fine as it is possible to get them. The finer and better the Livers and Fat are ground, the finer and better will be the Liver Sausage.

Fourth:—When grinding, add to 100 lbs. of Sausage:
3 large size Onions.
Bull-Meat-Brand Sausage Binder in percentage proportion of cereal as allowed by your State Pure Food Law.
6 to 8 ozs. of Zanzibar-Brand Liver Sausage Seasoning.
1 lb. "A" Condimentine.

All of these should then be well mixed, and as much of the Water in which the Meat was boiled should be added to the mixture as the Meat will absorb.

Fifth:—Stuff very loosely into Hog Bungs or Beef Casings, and boil very slowly, otherwise, they will burst; never have the water hotter than 155 degrees. The length of time to boil is ½ to 1 hour, which will depend entirely upon the thickness of the Sausage.

Sixth:—After they are boiled, place in ice water, in which they should be kept until they have been chilled through to the center; then remove them from the water and place in the cooler. After the Sausages are chilled rub the casings with some White Berliner Brand Konservirung Salt, to prevent the Sausage from getting slimy.

DIRECTIONS FOR MAKING BRAUNSCHWEIGER LIVER SAUSAGE.

Braunschweiger Liver Sausage is made of neck pieces from Lean Hogs, Hog Livers, Gut Fat, Trimmings from Bellies and Back Fat, all of which must be steamed before being chopped. For 150 lbs., or less amounts in the same proportion, take:

10 lbs. Gut Fat.
30 lbs. of Belly Trimmings.
20 lbs. of Back Fat.
40 lbs. of Neck Pieces.
50 lbs. of Hog Livers.

First:—Take the above quantities, put them into a kettle and steam them at about 180 degrees or 190 degrees until the meat is tender. **Care must be taken** that the water does not boil. It should not be hotter than 190 degrees or just enough **heated** to make it simmer.

Second:—Separate the Livers from the other Meat that has been steamed and chop it or grind it fine.

Third:—Take all of the other Meat out of the kettle, strip it from the bones and rinds, put it in a chopper or grinder, and chop, rock or grind fine. The finer the better. While chopping add:

5 large size Onions.
The Bull-Meat-Brand Flour
10 to 12 ozs. Zanzibar Brand Liver Sausage Seasoning.
1 lb. "A" Condimentine, and as much of the Soup in which the Meat was steamed as the Meat will absorb.

Fourth:—Then put all of the chopped Meat, including the Livers, into a trough and mix all the Meat thoroughly, adding as much more of the Soup while mixing, as the mixture will absorb.

Fifth:—Stuff loosely into Hog Middles or Hog Bungs, and boil very slowly, otherwise, they will burst; boil them until they are filled and swell out. Never have the water hotter than 155 degrees. The length of time to boil is ½ to 1½ hours, which will depend entirely upon the thickness of the Sausage.

Sixth:—After they are boiled, place in cold water—ice water is the best—in which they should be kept until they have been chilled through to the center, but while chilling the Sausages must be turned frequently to keep the grease from congealing to one side; then remove from the water, and place in a cooler. After the Sausages are chilled, rub the casings with some White Berliner Brand Konservirung Salt, to prevent the Sausage from getting slimy.

Seventh:—If it is desired to smoke the Braunschweiger Liver Sausage it can be smoked the following day.

SMOKED COLORED LIVER SAUSAGE

Color the casings in a solution of our Zanzibar-Carbon Brand Casing Yellow Mixture by momentary dipping before watering, cutting and tying them. This will give Liver Sausage the desired smoke shade color.

BLOOD SAUSAGE

BLOOD SAUSAGE.

Blood Sausage is always made from partially Cured Meat. This Meat should be cured for 10 to 14 days in a brine made as follows:

1 lb. Freeze-Em-Pickle.
7 lbs. Salt.
5 gals. Water.

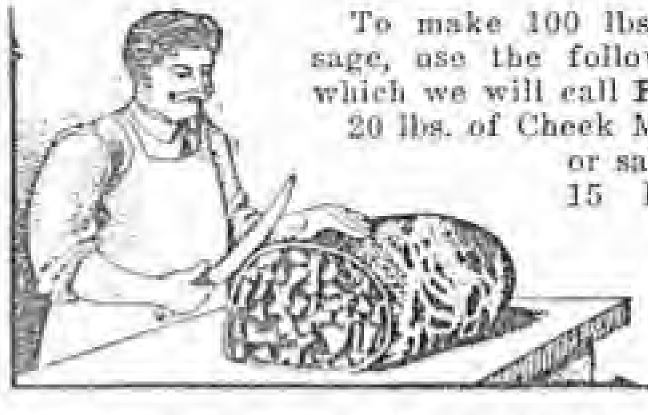
Blood Sausage made from Meat which has been cured by the Freeze-Em-Pickle Process will have a delicious flavor and will keep well in any climate.

Use Bull-Meat-Brand Sausage Binder, in percentage proportion of cereal allowed by your State Food Law, in making Blood Sausage, as it tends to absorb fat and meat juices, preventing the Sausage from drying out so readily and becoming unpalatable.

TONGUE BLOOD SAUSAGE

Tongue Blood Sausage is made the same as either Formula No. 1 or Formula No. 2, with the exception that Cured Hog Tongues are added to it. The more Tongues used, the better will be the sausage. Always use Tongues that have been thoroughly cured by the Freeze-Em-Pickle Process as they will have a nice red appearance in the Sausage. Boil the Tongues until they are done and then cut into strips and mix into the sausage at the same time as the blood is added.

DIRECTIONS FOR MAKING BLOOD SAUSAGE.



To make 100 lbs. of Blood Sausage, use the following proportions which we will call **Formula No. 1:**

20 lbs. of Cheek Meat, either fresh or salted.
15 lbs. of Hearts, either fresh or salted.
15 lbs. of Pork Rinds, either fresh or salted.
20 lbs. of Pork Speck (back fat), either fresh or salted.
25 lbs. (3 gallons) of Hog or Beef Blood.
Bull-Meat-Brand Sausage Binder in percentage proportion of cereal as allowed by your State Pure Food Law.
6 to 8 ozs. Zanzibar-Brand Blood Sausage Flavor.
½ lb. "B" Condimentine
2 lbs. of Salt, to suit taste.
½ lb. **Freeze-Em-Pickle.**

Salted Meat is preferable in making Blood Sausage but fresh Meat can be used if desired.

First:—Take 25 lbs. of Fresh Hog or Beef Blood, and stir until the blood remains thin and will not congeal.

Second:—Put the Pork Rinds in a pudding net and boil until about three-quarters done. Care must be taken not to boil them too long, otherwise they will become too pulpy when boiled the second time in the Sausage.

Third:—Boil the Cheek Meat and Hearts until done. The Cheek Meat and Hearts should be boiled as slowly as possible. The slower the boiling the better will be the Sausage.

Fourth:—After they are cooked, put the Pork Rinds in a chopper or meat grinder and cut them as fine as possible. The finer the better. After the Cheek Meat and Hearts have been cooked, they should be cut up coarse by hand, or chopped coarse in a chopper.

Fifth:—The Pork Back Fat must be scalded by pouring boiling water over it for a few minutes. It should then be cut into small squares or cubes by hand or with a pork back fat cutting machine.

Sixth:—After the Meat and Fat are all cut, add to it:

25 lbs. of Beef Blood
The legal amount of Bull-Meat-Brand Sausage Binder.
6 to 8 ozs. Zanzibar Brand Blood Sausage Seasoning.
Salt to suit taste.

Seventh:—Mix these thoroughly and stuff into Beef Bungs, Beef Middles or Rounds. Fill the casings only three-quarters full.

Eighth:—Blood Sausage should be boiled very slowly, the water should not be hotter than 155 degrees. The length of time for boiling depends entirely upon the thickness of the Sausage. When done, the Sausage will float on top of the water and will be firm and plump. It will be necessary to prick the Casings when boiling to let out the air.

Ninth:—When the Sausage is cooked through, remove it from the kettle and place it in cold water; ice water is the best. Allow it to remain in this

cold water until it is thoroughly cooled. Then, place on a board in a cooler and allow it to remain there 24 hours before cutting.

Tenth:—It is always advisable to use pickled or dry-salt cured Cheek Meat and Hearts for Blood Sausage instead of fresh ones. To cure them especially for Blood Sausage, they should be cured in brine made with **Freeze-Em-Pickle** according to directions in first paragraph of this article, for two weeks before being made into Sausage. Some prefer to grind the Hearts fine, and leave the Cheeks coarse, and if this is preferred, the Hearts can be ground with the Pork Rinds.

Formula No. 2, for making 100 lbs. of Blood Sausage:

30 lbs. of Pork Speck (back fat).
35 lbs. of Pork Snouts or Ears.
30 lbs. of Hog or Beef Blood.
Bull-Meat-Brand Sausage Binder in the percentage proportion of cereal as allowed by your State Pure Food Law.
6 to 8 ozs. Zanzibar-Brand Blood Sausage Flavor
½ lb. "B" Condimentine.
½ lb. of **Freeze-Em-Pickle.**
2 lbs. Salt.

Cook and handle Formula No. 2 the same as Formula No. 1, with the exception of leaving out the Hearts and Cheek Meat.

DIRECTIONS FOR MAKING SUMMER SAUSAGE (CERVELAT)

Use 70 lbs. of Pork Trimmings, 20 lbs. of Lean Beef, 10 lbs. of Pork Back Fat.

First:—Before being made into Sausage, the Back Fat must first be dry salted for two weeks in order to get it properly cured and firm.

Second:—After the Pork Back Fat has been dry salt cured, it should be cut up into small pieces of about one-half inch square.

Third:—The Beef should be first finely chopped; then the Pork Trimmings should be added and then the Pork Back Fat. The meat should be chopped until fine and while it is being chopped add:

2 lbs. of Salt.

½ lb. "B" Condimentine.

8 ozs. Best Granulated Sugar.

10 to 12 ozs. Zanzibar-Brand Summer Sausage Seasoning.

Bull-Meat-Brand Sausage Binder in percentage proportion of cereal as allowed by your State Pure Food Law.

Fourth:—When the Meat is chopped, it should be packed tightly in pans or boxes which should be placed in a cooler having a temperature of about 40 degrees; these pans or boxes should hold about 50 lbs. and should be shallow, not over six to eight inches deep, so that the Meat can be thoroughly chilled through. The Meat in these pans or boxes should remain in the cooler from four to six days before it will be ready to stuff into the Casings.

Fifth:—Stuff the Sausage into Hog Bung Casings or Beef Middle Casings and hang them in a dry room in a temperature of about 45 to 50 degrees for two or three weeks.

Sixth:—They can then be smoked and are ready for the market.

DIRECTIONS FOR MAKING ITALIAN STYLE SALAMI SAUSAGE

Take 50 lbs. of Pork Trimmings.
20 lbs. Lean Beef.
20 lbs. Pork Back Fat.
Bull-Meat-Brand Sausage Binder in percentage proportion of cereal allowed by your State Pure Food Law.

1 lb. of **Freeze-Em-Pickle.** 8 ozs. of Granulated Sugar.
¼ lb. of "B" Condimentine. 2 lbs. of Salt.
10 to 12 ozs. of Zanzibar-Brand Summer Sausage Flavor.
2 to 3 ozs. of Vacuum-Brand Garlic Compound or Garlic Condiment.

First:—Before being made into sausage, the Back Fat must first be dry salted for two weeks to get it properly cured and firm.

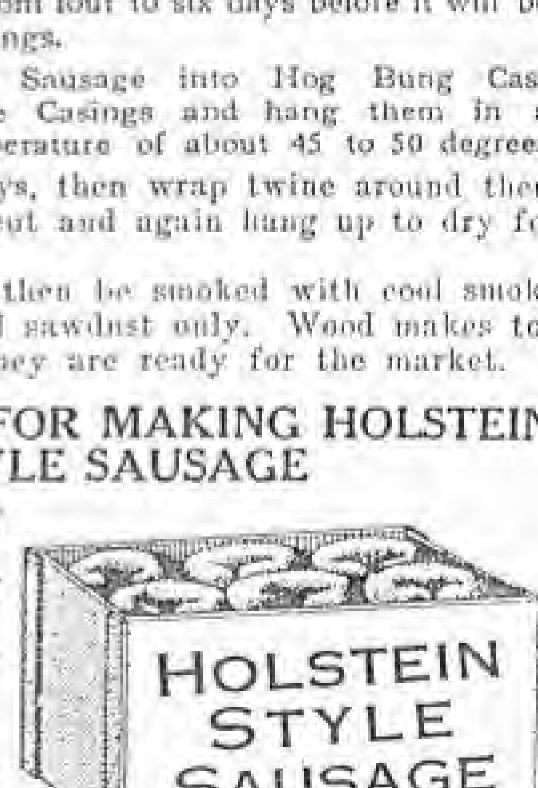
Second:—Chop Pork Trimmings and Beef quite coarse, coarser than for Summer Sausage. While chopping add the Bull-Meat-Brand Sausage Binder, **Freeze-Em-Pickle**, Salt, Sugar, Seasoning, "B" Condimentine and Garlic Compound or Garlic Condiment, and when it is partly chopped add the Back Fat which has previously been cut in cubes about one-half inch square. By adding the Back Fat last it will still be in quite large pieces when the Meat is sufficiently chopped. The Fat should show quite prominently in Salami, as it must be fatter than Summer Sausage. Two or three ounces of Vacuum-Brand Garlic Compound or Garlic Condiment should be added while being chopped to give it a delicious Garlic flavor. The quantity may be varied according to the demands of the trade.

Third:—When the Meat is chopped, it should be packed tightly in pans or boxes, which should be placed in a cooler having a temperature of about 40 degrees. These pans or boxes should hold about 50 lbs. and should be shallow, not over six to eight inches deep, so that the Meat can be thoroughly chilled through. The Meat in these pans should remain in the cooler from four to six days before it will be ready to stuff into Casings.

Fourth:—Stuff the Sausage into Hog Bung Casings or Beef Middle Casings and hang them in a dry room. in a temperature of about 45 to 50 degrees for two or three days, then wrap twine around them nicely as shown in cut and again hang up to dry for two to three weeks.

Fifth:—They can then be smoked with cool smoke made with hardwood sawdust only. Wood makes too much heat. Then they are ready for the market.

DIRECTIONS FOR MAKING HOLSTEIN STYLE SAUSAGE



Take 50 lbs. of Pork Trimmings.
40 lbs. of Beef Trimmings.
10 lbs. of Pork Back Fat.

First:—Before being made into Sausage, the Back Fat must first be dry-salted for two weeks in order to get it properly

cured and firm.

Second:—Put the Beef into the chopping machine and while chopping it add:

2 lbs. of Salt.

¾ lb. "B" Condimentine

1 lb. of Freeze-Em-Pickle.

8 oz. of Best Granulated Sugar.

Bull-Meat-Brand Sausage Binder in percentage proportion of cereal as allowed by your State Pure Food Law.

1 small teaspoonful of Vacuum-Brand Garlic Compound or Garlic Condiment.

Let the Beef chop until about one-half done before adding the Pork; then chop the Pork and Beef some before adding the square cut pieces of Pork Back Fat.

Third:—After the Meat is chopped and spiced put it in shallow boxes or pans not over eight inches thick, and put it in a good cooler. Keep the Meat in a cooler for from 4 to 6 days so it is thoroughly cured before it is stuffed.

Fourth:—Stuff in Beef Round Casings and let the Sausage hang in a dry room at 45 to 50 degrees of temperature for a week.

Fifth:—Then give them a good smoke and they are ready for the market. Cool smoke is produced with hickory, hard maple or oak saw dust only. Wood gives off too much heat.

HOW TO COLOR THE CASINGS FOR HOLSTEIN STYLE SAUSAGE

See directions for momentary dipping on page 83. This method can be used equally well on the empty casings. After the casings have a light orange color take them out of the solution and wash them well in hot water, cut and tie them, then stuff the casings and hang the sausage up to dry.

After the sausage has hung a week or two and is dry, hang it in the smoke house for a few days to give it a smoke flavor and it is ready for shipment. This will save a large shrinkage and the sausage will have a better appearance. Sausage that has had the casing colored before being stuffed need not become rancid, as it is not exposed to the heat in a smoke house, which heat always causes the stearin and oil in the fat to separate, and as soon as this change takes place the sausage begins to become rancid.

SWEDISH STYLE SAUSAGE

Take 60 lbs. of Beef. (Boneless Chucks, Briskets and Shank Meat can be used.)

30 lbs. of Pork Ham Trimmings.

10 lbs. of Back Fat.

First:—Before being made into Sausage, the Back Fat must first be dry-salted for two weeks in order to get it properly cured and firm.

Second:—Cut up the Pork Back Fat into square half-inch cubes by hand or with a Pork Back Fat Cutting Machine.

Third:—Put the Beef and Pork on the block and when partly or coarsely chopped add the cubes of Back Fat, and when the Beef and Pork are cut fine, the Pork Back Fat should show prominently through the meat.

While it is being chopped add:

2 lbs. of Salt.

½ lb. "B" Condimentine.

Bull-Meat-Brand Sausage Binder in percentage proportion of cereal as allowed by your State Pure Food Law.

1 lb. Freeze-Em-Pickle.

8 ozs. Best Granulated Sugar.

10 to 12 ozs. Zanzibar-Brand Swedish Style Sausage Seasoning.

Fourth:—After chopping fine, put the Meat in a trough and knead it with the Bull-Meat-Brand Sausage Binder until it is tight and hard.

Fifth:—Pack the Meat tightly in 50 lb. pans or boxes which place in a cooler having a temperature of about 40 degrees; these pans or boxes should be shallow, not over 6 to 8 inches deep, so that the Meat can be thoroughly chilled through. The Meat in these pans or boxes should remain in the cooler 4 to 6 days before it will be ready to stuff into the Casings.

Sixth:—Stuff the Sausage into Beef Middles and hang them in a dry room in a temperature of about 45 to 50 degrees for two or three weeks.

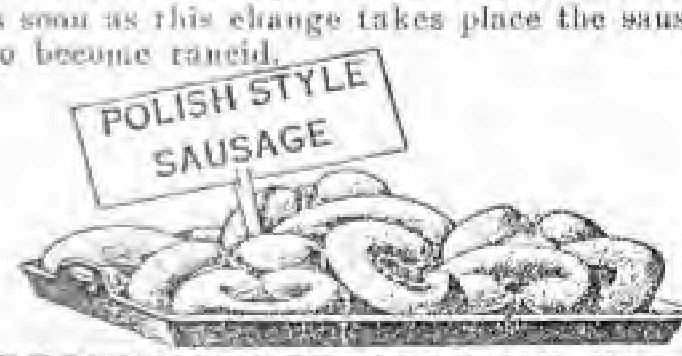
Seventh:—They can then be smoked with cool smoke made with sawdust and are ready for the market.

HOW TO COLOR THE CASINGS FOR SWEDISH STYLE METWURST

See directions for momentary dipping on page 83. This method can be used equally well on the empty casings. After the casings have a light orange color take them out of the solution and wash them well in hot water, cut and tie them.

After the Sausage has hung a week or two and is dry, hang it in the smoke house for a few days to give it a smoke flavor and it is ready for shipment. This will save a large shrinkage and the Sausage will have a better appearance.

Sausage that has had the casing colored before being stuffed need not become rancid, as it is not exposed to the heat in a smoke house, which heat often causes the stearin and oil in the fat to separate, and as soon as this change takes place the sausage begins to become rancid.



DIRECTIONS FOR MAKING POLISH STYLE SAUSAGE

Take: 50 lbs of Pork Trimmings.
40 lbs. of Beef Trimmings.
10 lbs. of Pork Back Fat.

Before being used in the Sausage, the Pork Back Fat should be dry salt cured for at least two weeks or it can be cut from dry salt sides.

First:—Cut up the Pork Back Fat into square half inch cubes by hand or with a Pork Back Fat Cutting Machine.

Second:—Chop the Pork Trimmings, Beef Trimmings and Pork Back Fat quite coarse, and while being chopped add:

2 lbs. Salt.
¾ lbs. "B" Condimentine.
1 lb. of Freeze-Em-Pickle.
10 to 12 ozs. Zanzibar-Brand Polish Style Sausage Seasoning
8 ozs. of Granulated Sugar.
2 to 3 ozs. Vacuum Garlic Compound or Garlic Condiment.

Bull-Meat-Brand Sausage Binder in percentage proportion of cereal as allowed by your State Pure Food Law.

Third:—After the Pork Trimmings and Pork Back Fat have been chopped and mixed with the Salt, "B" Condimentine, Bull-Meat-Brand Sausage Binder, **Freeze-Em-Pickle** and Vacuum Brand Garlic, stuff into beef round casings.

Fourth:—After the sausage has been stuffed into casings place them in the smoke house and thoroughly smoke with wood. This Polish Style Sausage should not be boiled when made. It is boiled when eaten.

HOW TO COLOR THE CASINGS FOR POLISH STYLE SAUSAGE

See directions for momentary dipping on page 2668. This method will work equally well on the empty casings. After the casings have a light orange color take them out of the solution and wash them well in hot water, cut and tie them.

After the Polish Style Sausage is stuffed, hang it in the smoke house for a few hours, using wood so as to have a hot smoke. This drys it and gives it a smoke flavor. Then it is ready for shipment. This will save a large shrinkage and the sausage will have a better appearance. Polish Style Sausage that has had the casing colored before being stuffed need not become rancid, as it is not exposed to so much heat in a smoke house, which heat always causes the stearin and oil in the fat to separate, and as soon as this change takes place the sausage begins to become rancid.

HOW TO MAKE FINE QUALITY BOCKWURST

First:—Take 45 pounds Beef, 20 pounds Veal, 20 pounds Lean Pork, 5 pounds Pork Back Fat (Speck).

Second:—The Meat should all be chopped very fine except the Speck, which should first be cut into small cubes and then added to the rest of the Meat when it is partly chopped so that small cubes of fat will show in the Sausage.

Third:—While chopping, add the following:

Bull-Meat-Brand Sausage Binder in percentage proportion of cereal as allowed by your State Pure Food Law.
½ lb. of **Freeze-Em-Pickle.**
¾ lb. "B" Condimentine.
1½ to 2 lbs. of Salt.
8 to 10 ozs. of Zanzibar-Brand Frankfurt Sausage Seasoning.
3 tablespoonfuls of very finely cut Chives.
6 heaping tablespoonfuls of finely chopped Parsley.
Sufficient artificial ice to keep the meat cool while grinding, added a little at a time.

Fourth:—When the meat is all cut up fine and properly mixed with the spice, it should be stuffed in Narrow Sheep Casings and turned off in links about 2½ inches long.

Fifth:—As a rule Bockwurst is sold without smoking, but it can be given a light smoke if desired.

Sixth:—To prepare Bockwurst for the table, it should be steamed five or six minutes in hot water.

Pork Sausage, Bologna, Frankforts, Head Cheese, Liver Sausage, etc., can be kept in a good condition, by simply putting them, every night, in a solution of 1 lb. of Cold-Storine dissolved in three gallons of water. This solution should be kept in the Cooler. In the morning remove the Sausage from the solution, hang it up and expose it for sale, and what remains unsold in the evening, simply put back in the brine for the night.

In this way Sausage can be kept fresh and nice appearing for some time, and it will not shrink and dry up. This enables the dealer to keep a large, attractive display on hand in his shop without any danger of the goods spoiling.

By keeping the Sausage in this way, it does not dry out, nor become slimy or moldy as it would if hung up in the cooler. Sausage can also be shipped a reasonable distance in a Cold-Storine solution to better advantage than if shipped in any other way.

On arrival it should be removed from the solution, hung up and allowed to drain and dry. In the evening it should be replaced in the same solution for keeping over night.

Never put Smoked Sausage and Fresh Sausage in the same solution. Each kind of Sausage should be kept in a separate solution.

FRESH TRIPE AND PIGS FEET.

Fresh Tripe and Fresh Pig's Feet turn dark and spoil very easily, but by placing them every evening in a Cold-Storine solution made of one pound of Cold-Storine dissolved in three gallons of water, they can be kept in a good condition for a number of days. Every morning they may be taken out of the solution, and those not sold during the day should be put back into the Cold-Storine solution overnight. The solution for Tripe and Pig's Feet should not be used for storing anything else in it.

SWEET BREADS AND BRAINS.

Sweet Breads and Brains can also be kept in the same way as Tripe and Pig's Feet.

First:—Clean the Feet as carefully as possible and then cure them in brine made as follows:

6 lbs. of Salt.
1 lb. of Freeze-Em-Pickle.
5 gals. of Water.

The Feet should be cured in this brine from four to five days. This brine can be used over and over again for curing Pickled Pigs Feet, until it becomes thick from the substances drawn out of the Feet.

Second:—After the Feet have been cured for four or five days, cook them as follows: Heat a kettle of water boiling hot; then throw the Pigs Feet into it and keep the heat on until the water begins to boil; then check the fire or steam, and simply let the water simmer just as slowly as possible until the Feet are nicely cooked. The slower they cook, the better, and they ought to remain in the hot water for about four hours, when cooked at a low temperature.

Third:—When they are cooked through, turn on cold water and let the water overflow until all the heat is out of them, and nothing but cold water overflows, and then let the Feet cool well.

Fourth:—Split the Feet through the center and pack them. If they are to be packed in tierces and kept on hand for any length of time, the vinegar that is put over them should be 60 grains strong, but when they are packed in small packages for immediate use 40 grains is strong enough.

Fifth:—When packing the Feet add to every 100 lbs. 8 to 10 ounces of Zanzibar Brand Pickled Tongue Seasoning.

STORING PICKLED PIGS FEET.

There are certain seasons of the year when Pickled Pigs Feet are in great demand, while there are other seasons when they are a slow sale. We, therefore, give here a formula for keeping Pickled Pigs Feet in vinegar so they can be kept for one year if necessary in a perfect condition. Salt, cure and boil the Pigs Feet the same as above, but instead of boiling them all done, boil them only about half done; then split them and put them in tierces and fill the tierces with 60-grain vinegar and store in cold storage. The 60-grain vinegar has a tendency to soften the meat. After they have been in this strength of vinegar for some length of time, they will become soft just as if they were thoroughly cooked, but if it is necessary to use them before they are soft, roll them into the engine room or in a place where it is very warm, and turn the tierces on their end. Keep the top of the barrel covered with water—we mean on the top of the head—so that the head will not dry. The bottom of the barrel will not shrink and dry because the vinegar on the inside keeps it moistened, but if the top is not kept wet the barrel will shrink and begin to leak. By allowing the Pigs Feet, which are packed in strong vinegar, to remain in a very warm place for a week or so, they will become nice and tender; they are then to be repacked with 40-grain vinegar in small packages for the market.

PICKLING TRIPE.

Select Tripe that is fresh and has not been lying around long enough to attract the bacteria ever present in the air.

Tripe should be prepared by thoroughly cleaning and washing the paunch in at least three or four changes of water. After that, a tub of cold water should be prepared and a lump of unslaked lime, the size of an English Walnut, should be added to about 50 gallons of water. Allow the lime to dissolve and then stir the water to thoroughly mix it. In this solution place the washed Tripe and allow it to soak for five or six hours. The water should be kept cold. A small piece of ice may be put in the water if necessary. Before the Tripe is put into the last soaking water, the inside should be scraped with a hog-scraper so as to remove the inside skin. The outside film or skin should also be scraped off. The boiling vessel should be thoroughly washed before the Tripe is placed in it for cooking. If there is any foreign substance whatever in the kettle, it will discolor the Tripe. On the other hand, it may be turned out perfectly white if the boiling vessel is in proper condition. Two ounces of B. Heller & Co.'s Lard Purifier mixed in 50 gallons of boiling water will assist to keep the Tripe White.

Scald the Tripe thoroughly and scrape both sides well with a hog-scraper. The Tripe is then ready to be cooked.

In cooking, allow the water to come to the boiling point. It should then be reduced to a simmer until the Tripe is thoroughly cooked. When cooked, cold water should be turned on and allowed to overflow until the Tripe has thoroughly cooled. After it is thoroughly cooled, pack in tierces with vinegar that

is 60 degrees strong. Always use White Wine Vinegar. If it is desired to ship Tripe after it has been vinegar-cured, it should be repacked in vinegar 40 degrees strong.

To give the Tripe a nice flavor, add to every 100 lbs. of Tripe 8 to 10 ounces of Zanzibar Brand Pickled Tongue Seasoning.

Many have trouble through their inability to cook Tripe tender. This, in most cases, is owing to the fact that the Tripe is boiled too much in water that is too hot. Water in which Tripe is being cooked should be allowed to come to a boil, after that, it should be put on a slow fire where it will cook the Tripe by simmering. A simmer is water that is hot, but not boiling, or 155 to 160 degrees. Boiling water will always shrink and toughen Tripe. It will take longer to cook some Tripe than others, depending upon the age of the animal from which it is taken. Tripe should be allowed to simmer until it is cooked tender.

MINCE MEAT.

The following directions will make a delicious Mince Meat:

Take 4 lbs. of lean Beef, boil it until it is fairly well cooked and then chop or grind it very fine.

Add 8 lbs. of Hard Green Apples, cut into small cubes.

1 lb. of very finely chopped suet.

3 lbs. of seeded Raisins.

2 lbs. of Picked Currants, carefully washed and dried.

2 to 5 lbs. of Citron, cut up into small pieces.

1 lb. of Brown Sugar.

1 pint Cooking Molasses (pure New Orleans Molasses is the best, and it must be free from Glucose).

1 quart of Sweet Cider.

1 Tablespoonful of Salt.

1 Teaspoonful of Ground Black Pepper.

1 Teaspoonful of Mace.

1 Teaspoonful of Allspice.

½ Teaspoonful of Cinnamon.

A little grated Nutmeg.

A pinch of Cloves.

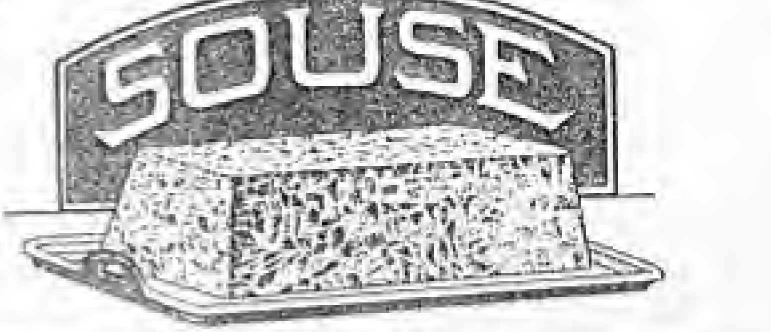
Mix the above thoroughly, then heat slowly on the stove and boil for half an hour.

If the Mince Meat is to be put in jars and sealed up tight, the hot Mince Meat should be put into pint and quart jars, the jars should be filled up to the brim and the tops screwed down tight immediately.

If the Mince Meat is to be kept in bulk and not sealed up in jars, add ½ pint of good Brandy after the Mince Meat has been cooked and allowed to become nearly cold, stirring the Brandy into the Mince Meat thoroughly and then pack into stone crocks, cover tightly and keep in a very cool place where the Mince Meat will not freeze. This Mince Meat will keep all winter.

The above quantities can be increased or decreased proportionately, according to the total amount of Mince Meat desired at one time.

Dry or concentrated Mince Meat is made same as above, except that dried apples are used instead of fresh apples, and no liquids are added. Wet Mince Meat is better than the dry and will give better satisfaction.



DIRECTIONS FOR MAKING SOUSE.

First:—Take nicely cleaned Pigs Feet, Pigs Snouts, Hocks, Tails or Ears, and put them in a kettle on a stove, or fire or in a steam jacket kettle.

Second:—Add just enough cold water to entirely cover them.

Third:—Boil until the Meat can be removed from the bones.

Fourth:—Remove the Meat from the bones, and put it back into the water in which it was boiled; then add to this water enough White Wine Vinegar to give it a nice sour taste. The quantity of vinegar will depend upon its strength.

Fifth:—Add the following proportions of spice, which can be changed to suit the amount of Souse you are making. For 100 lbs. Souse use:

2 lbs. of Granulated Sugar.

8 to 10 oz. Zanzibar-Brand Pickled Tongue Seasoning.

Sixth:—Mix the spice with the Meat, and boil about 15 minutes; then remove from the fire. Put the Souse into square tin pans, and allow it to set 24 hours before removal. If desired, a lemon and 2 or 3 good sized Onions may be cut into small pieces, and mixed in the Souse before it is boiled; some like this, and some prefer it without Onion or Lemon. Do not use too much Lemon as it will make the Souse taste bitter.

VINEGAR PICKLED PIGS TONGUES.

Take salted Pigs Tongues that have been cured for 30 days and scald them in hot water; then remove the skin and gullet. Boil slowly for three hours, the same as boiling Pigs Feet; the slower they are boiled the better; then cool the Tongues, in the same manner as directed for cooling Pigs Feet.

Another way is to take them out of the Brine and cook them, and then take off the skin and gullet after they are cooked. When handling large quantities, this latter method will not work as well as the first method, because after the Tongues are boiled, they must be cooled in the same vat, and after they are cooled, the skin does not remove so easily. That is why it is better to scald them in boiling water first and then remove the skin and gullet, then boil them.

Split the tongues through the center and pack in Vinegar the same as Pigs Feet and add to every 100 lbs. of Tongues 8 to 10 ounces Zanzibar-Brand Pickled Tongue Seasoning.

HORSERADISH.

Home-made horseradish is a relish that every household demands. It is impracticable to put grated horseradish upon the market except when bottled, as exposure to the air discolors it and dries it out. An excellent bottled article which will prove a good keeper as well as a good seller can be made as follows: To ten parts of grated horseradish add one part of granulated sugar and one part of pure vinegar. In preparing horseradish none but white wine vinegar should be used. One of the best means of getting new trade is for a Butcher to sell home made grated horseradish.

SAUER KRAUT.

Select sound cabbages and peel off the first or damaged leaves, then slice or shave with a cabbage cutter as fine as possible. The object desired in making first-class Sauer Kraut is to obtain a perfect fermentation under pressure with the aid of salt alone. The brine, therefore, results from the water contained in the salt and cabbage, no water being added. First secure a good strong cask, which should be well scalded and cleaned. Sprinkle on the bottom of this cask a small quantity of salt, then put in a layer of cabbage and while adding the cabbage sprinkle some salt through it, so that the salt is as much divided as possible and then tamp well with a wooden tamper, so as to pack it as tight and solid as possible. Continue putting in layer of cabbage and tamping this way until the barrel is full. The salt to be used should always be of the best grade and one pound of salt to one hundred pounds of cabbage should be used but may be varied according to the taste. Some prefer it saltier than others. After the cask is filled or as full as desired, the cabbage should be covered with a clean cloth on which should be laid hardwood boards. Use the boards taken out of the head of a whiskey barrel or tierce as this makes the best cover, as they fit in the barrel and are made of hardwood and will not give the cabbage a taste. Carefully weight the boards down with heavy stones, always remembering that the fermentation should be accomplished under pressure. Once a week take off the stone, board and cloth from the cabbage and wash them clean and replace the cloth and boards and stones on top of the barrel after they have been washed. By repeating the washing of the boards and cloth and stones every week, the top of the cabbage will be kept perfectly sweet and the foam which comes to the top is removed, so that the top of the Sauer Kraut will be as good as that in the bottom of the barrel. The Kraut should be left to ripen for about four weeks in a warm temperature. It is always best not to offer it for sale until it has sufficiently ripened and is tender and juicy and that it has the proper flavor. This can only occur after perfect fermentation has taken place.

PICCALILLI.

This sauce is easily prepared and is in considerable demand by some trades. Select good, firm, green tomatoes, wash them thoroughly and cut away all defective portions of the tomatoes. They should then be sliced or quartered and placed in a salt brine made with one pound of salt to each gallon of water with a supply of green peppers. Let them cure in this brine for two weeks. They may then be taken out and chopped very fine, about ⅛ to ¼ inch in diameter. They are then ready for the vinegar, which should be pure in quality, the white wine vinegar being preferred. The vinegar should be first prepared or sweetened and spiced with pure granulated cane sugar, cloves, cinnamon, mustard seed and a small quantity of celery seed. This can be poured over the chopped tomatoes and peppers, either hot or cold. Piccalilli should be sold nearly or quite strained of its vinegar.

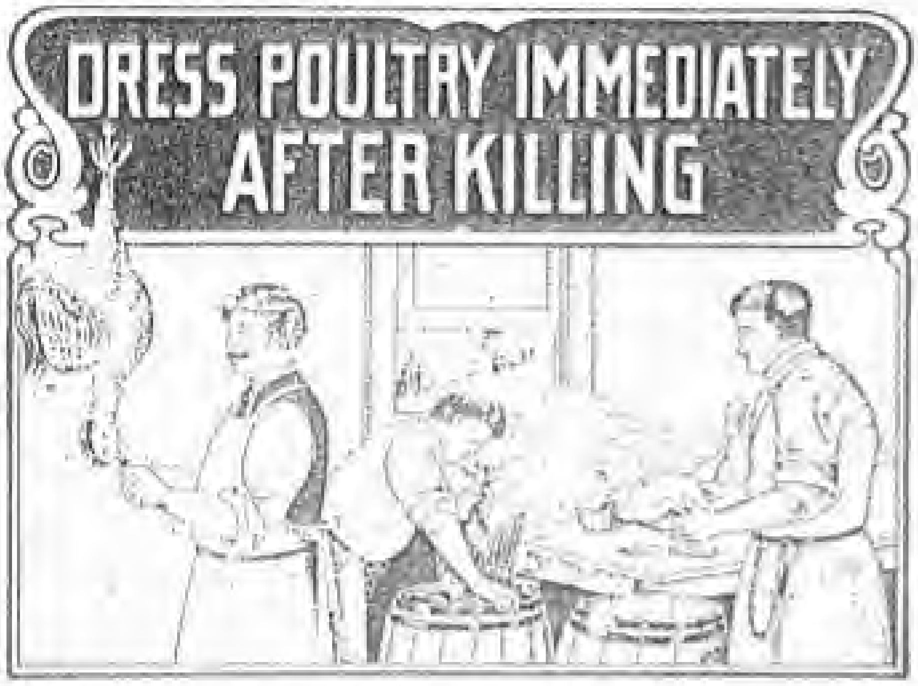
CHOW CHOW.

Chow Chow is a popular sauce that can be readily prepared. It is strictly a Chinese innovation which was introduced to the American palate during the first immigration of Chinamen. It is merely the cucumber pickle cut up into small pieces with the addition of cauliflower, onions, etc., over which is poured a preparation of mustard, vinegar and various condiments which taste may demand. Chow Chow is a good keeper and a good seller, but in order to retain its flavor and color, it should be carefully covered and kept from exposure to the air.

DILL PICKLES.

All butchers should put up home made pickles of all kinds and such relishes as horseradish and sauer kraut. Dill pickles are very popular and they are always salable in the butcher shop. They may be made as follows: Select large pickles of as near an even size as possible and soak in water over night; then wash them thoroughly. Next, take a barrel and put a layer of dill about one inch thick on the bottom of it, upon which place the pickles three layers deep. Over these pickles place another layer of dill and repeat the layer of pickles as in the first instance. Continue this operation of the layer of dill and then pickles until the barrel is as full as desired, leaving sufficient space for the brine. The brine should be made of the best quality of salt, using ½ lb. to each gallon of water. Brine thus made will make the natural soft home-cured dill pickles. After the brine has been placed over the pickles, place them in a cooler and let them ripen for about four weeks. The ripening process may be quickened about two weeks by leaving the pickles in a room of moderate temperature. Some prefer dill pickles hard and for such taste it is necessary to put a little alum in the brine. Pickles treated with alum must be labeled to show this. A piece about as big as an egg for a full barrel of pickles is the proper amount. Dissolve this in the brine. This will keep the pickles firm and

hard. It will be found, however, that most tastes prefer the natural brine without the alum, as the soft pickle seems to have a more appetizing flavor. There is no appetizer more appreciated than the dill pickle and it comes nearer appealing to the general trade than most any relish that can be offered.



HOW TO DRESS POULTRY.

The Butcher who will make a specialty of dressed poultry will make a hit with his customers and good profit on sales if he will be careful to get his Chickens dressed decently, and to educate his customers to pay prices that will be commensurate with the quality of the meat offered. Very often it is almost an impossibility for the consumer to secure sweet, untainted Poultry Meat. Much of this trouble is owing to the fact that large shippers kill the Chickens, dry pick them or scald them, and the food that remains in the intestines ferments and taints the meat, with the result that the Chicken, when cooked, has an abominable taste.

When a Butcher is so situated that he can dress his own Chickens, and he would be fully justified in making all preparations in that direction, he ought to open, draw and wash out thoroughly every chicken as fast as it is killed, just as he would wash out Hogs, Calves or Sheep. Chickens that have been nicely drawn and washed immediately upon killing are always sweet in flavor, and the Butcher who will take the pains to offer such goods and to acquaint his customers of their quality can not only establish a large trade and a great reputation, but he can offer the public an article that is pure and sweet, and difficult to obtain. No doubt he could command the Chicken trade of any neighborhood by this means, down all competition, and obtain good prices for his Meat, as people would be willing to pay for the original weight of the chicken before drawing, and at the same time would be much better satisfied with what they get. If desired, the Butcher could weigh the chickens after they are dressed, tag and draw them, and then could say to his customers: "This Chicken weighed so much before it was drawn, but in order to retain the sweetness of the meat, we draw it as it ought to be drawn, wash it out, and sell it to you for just what it is worth." A Butcher's statement upon these points would not be doubted. Furthermore, the Butcher would not lose anything by this method, as Chickens shrink after they are dressed and kept two or three days before sold. The loss from this shrinkage is considerable. Therefore, the trouble and expense of drawing Chickens and handling them in the manner described would be fully repaid.

STICKY FLY PAPER.

Every Butcher can make his own Sticky Fly Paper with very little trouble. It is made as follows:

1 lb. Rosin.
3½ oz. Molasses.
3½ oz. Boiled Linseed Oil.

Boil the three together until they get thick enough and then spread on heavy Manilla paper. The proper and quickest way is to take a sheet of heavy Manilla paper and spread the mixture on half of the surface of it, then double the paper over; the mixture put on the half will be quite sufficient to coat the face of the other half that is doubled over on it. The cost of making this sticky fly paper is very small and in an hour any Butcher can make enough Sticky Fly Paper to last the entire summer.

One of the things much neglected in many butcher shops is the making of Lard. Butchers who do not cut up enough hogs to have fat for making Lard each day, allow the fat to accumulate until they have sufficient so as to make it worth their while to render it. Many butchers do not keep this fat in the ice box, but let it stand anywhere, because they imagine that it does not spoil; then, when they make Lard out of it, they wonder why the Lard is not better.

Lard should always be made as soon as possible, and the fat trimmings should be kept in the cooler and not allowed to remain standing around in a warm place. To make high grade Kettle-Rendered Lard, always cut the rinds off of the fat. The rinds can be put into pickle and stored until a quantity has accumulated and then they can be cooked and utilized in Liver Sausage, Head Cheese or Blood Sausage. When the rind is cooked with the lard, it always causes more or less detriment to the lard.

Before rendering, if one has the machinery, the fat should be run through a regular fat hasher or a Meat Grinder, and it should be ground up into small pieces. The smaller it is ground the better, for if the fatty tissues are thoroughly mangled and disintegrated, the oil will separate more readily when the heat is applied. Those butchers not having a ma-

chine in which they can cut up the fat should cut it into small pieces by hand.

For making Kettle-Rendered Lard a steam jacket kettle is the best, but if one does not have steam, a common caldron will answer, but great care must be taken not to scorch the lard or allow it to become too hot when a caldron is used.

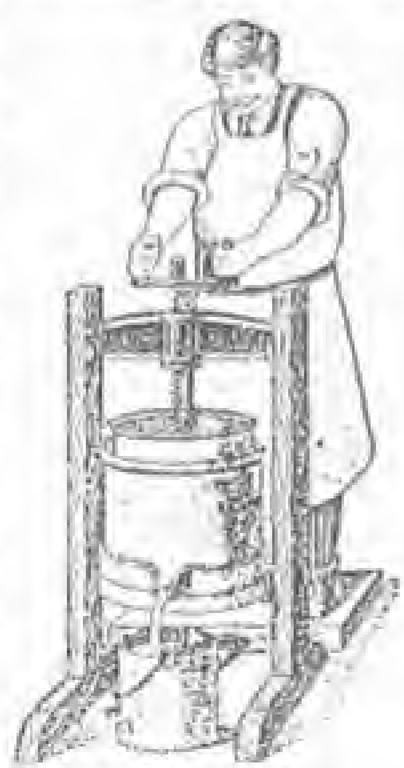
RENDERING LARD IN JACKET KETTLE OR CALDRON.

Before putting the fat into the kettle, put in a gallon of water for every 100 lbs. of fat, as the water prevents the lard from scorching. Then put in all the fat to be rendered and start the fire or slowly turn on the steam, as the case may be.

In rendering Lard the heat should be brought up gradually, so that quite a little of the fat is melted before the full heat is applied. If the heat is brought up too rapidly, it will cause the Lard to be darker in color than when it is gradually heated.

Lard should be boiled about 1½ hours after the entire mass is boiling.

Those butchers who wish to render their Lard scientifically, with the aid of a thermometer, can do so by hanging a thermometer in the Lard and bringing the temperature gradually up to 255 to 260 degrees Fahrenheit, and then turn off the steam or check the fire, as the case may be, and allow the Lard to cook slowly until it is finished.



LARD PRESS

A butcher can always tell when the Lard has cooked sufficiently by the way the cracklings press out.

After the Lard has all been tried out, skim out all the cracklings, put them into a press and press out all the Lard, adding what is pressed out to that, in the kettle.

Now the Lard is ready to be strained through a piece of cheese cloth.

HOW TO PURIFY LARD WITH ONLY A COMMON RENDERING KETTLE.

After the Lard has been rendered as above, treat as follows: The kettle must not be too full of Lard; it should not be more than three-fourths full when being treated with the Purifier.

Put a thermometer into the Lard to test the temperature. If the temperature of the Lard is below 200 degrees Fahrenheit, add to every 100 lbs. of Lard 3 ounces of B. Heller & Co.'s Lard Purifier, dissolved in one quart of water. For example, if the kettle contains 400 lbs. of rendered Lard, add 12 ounces of Lard Purifier dissolved in one gallon of water.

Should the temperature of the Lard be over 200 degrees F., do not add the Lard Purifier and water, but let the Lard stand for half an hour or so, until the temperature comes below 200 degrees.

If the Lard Purifier and water are added to the Lard when it is as high as 212 degrees F., the water will at once be converted into steam as soon as it gets into the Lard, because water is converted into steam at that temperature. When the Lard Purifier and water are added to Lard that is too hot, the Lard will foam up and boil over; but, when the Lard is below 200 degrees F. and the Lard Purifier and water are added, it will not boil up.

After adding the Lard Purifier and water, take a paddle and stir the Lard thoroughly, so the Lard Purifier is mixed thoroughly with every part of the Lard; then turn on the steam or build up the fire slowly, as the case may be, and heat the Lard up to 212 degrees F. The minute 212 degrees is reached the Lard will begin to foam. When the Lard gets to this point, it should not be left for a moment, because if it gets too hot it will boil over the top of the kettle; but if one stays right with it when it begins to foam, and checks the fire, it will not boil over but will foam a little and most of the impurities will rise to the top of the Lard. Now stop the fire and skim off all the impurities on the top of the Lard and allow the Lard to settle for about two hours, when all the water and the smaller impurities that did not rise to the top will have separated from the Lard and will be at the bottom, and one will be surprised at the amount of impurities that will thus be separated from the Lard.

If the kettle has a faucet at the bottom, draw off the water and the impurities which have settled and then run off the Lard. Should the kettle not have an opening at the bottom, dip out the Lard from the top, being careful not to dip out any of the water which will be at the bottom. When most of the Lard has been taken out, that remaining, which is near the water, can be dipped out together with the water, and put in a bucket or tub and allowed to harden.

The lard will float on the top and when hard can easily be taken off from the top of the water, and should be kept until the next Lard is rendered, when it should be re-melted with the next batch of Lard.

Before running the Lard into buckets, it is always well to run it through a piece of cheese cloth, so as to remove any small pieces of detached cracklings. It is advisable to put the Lard into the ice box as soon as it is run into buckets, so as to set it, which will prevent the separation of the oil from the Stearin.

IF ONE HAS NO SETTLING TANK, BUT SIMPLY HAS A RENDERING KETTLE AND AN AGITATOR, HANDLE LARD AS FOLLOWS:

First:—Render the Lard in the Rendering Kettle, and treat it with B. Heller & Co.'s Lard Purifier, the same as directed in the foregoing. After it is treated, run the Lard through two or three thicknesses of cheese cloth, into the Agitator. Allow it to settle in the Agitator for two hours, then run off all the water from the bottom, and start the Agitator. The Lard should be agitated until it is thick like cream, then it is ready to run off. We, however, recommend that Lard should be taken from the Rendering Kettle and put into the Settling Tank and allowed to settle, and then the Lard should be run from the Settling Tank through the faucet about an inch above the bottom, into the Lard Cooler, and while in the Cooler it should be agitated until it becomes thick. There are always small

particles of charred tissue which will settle to the bottom of the Settling Tank, which cannot be gotten out in any other way, and the Lard will be whiter and purer if allowed to settle in the Settling Tank and then drawn off into the Cooler.

IF ONE HAS A LARD SETTLING TANK, AS HERE ILLUSTRATED, HANDLE THE LARD AS FOLLOWS:

After treating the Lard as directed, with Lard Purifier and water, and after the Lard has been treated enough to make it foam, and the foam has been skimmed off, dip the Lard and water out of the kettle, run it through a piece of cheese cloth into the settling tank. A settling tank is simply a galvanized iron tank with a large faucet at the bottom. The bottom can be made to taper to the center and the faucet placed in the center, so all the water can be drained off, or the bottom can be made flat with the faucet close to the bottom, and the tank can be set slanting, so the water or Lard will all drain out.

SETTLING TANK

After the Lard is in the settling tank, let it settle for one or two hours, according to the size of the tank and quantity of Lard in it. Then drain off all the water and the impurities which have settled to the bottom. After these are drawn off, the Lard is ready to be run into buckets, which should be placed in the ice box to cool.

A better way is to let the Lard settle in the settling tank and, after the water is drawn off, stir the Lard with a large paddle until it is thick and creamy, and then it should be put into buckets. By letting it cool in the settling tank and stirring it until it is thick and creamy, Lard will have a much better appearance when cold than Lard that is run into buckets hot.

HOW TO PURIFY RENDERED LARD.

First:—Put 100 lbs. of water into the lard kettle and add to it one-quarter to one-half pound of B. Heller & Co.'s Lard Purifier; then on top of the water put 100 lbs. of the rendered Lard.

Second:—If a steam kettle is used, turn on the steam; and if the kettle is heated by fire, start the fire; the heat should be applied slowly and must be closely watched, so that the Lard does not get too hot and boil over. In no case should more Lard and water be put into the kettle than to fill it one-half full. By thus having the kettle only half full it leaves plenty of room for the Lard to boil and foam and prevents it from boiling over the top of the kettle.

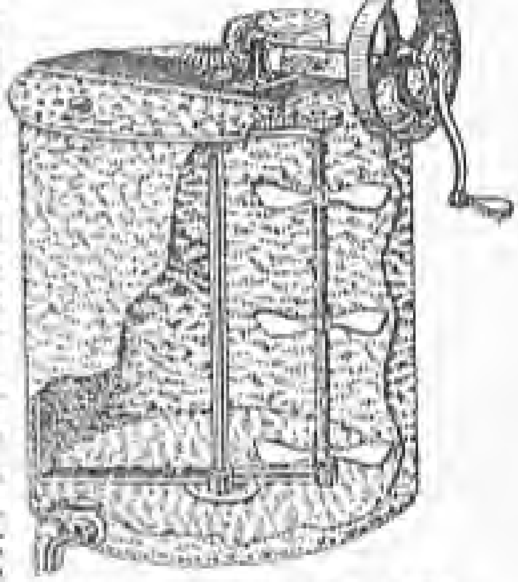
Third:—While the Lard is being heated stay right with it at the kettle to watch it and continually stir it.

Fourth:—When the Lard begins to boil check the fire and let it simmer from 10 to 15 minutes, then put out the fire or turn off the steam and let the Lard settle for about three hours; all the impurities that come to the top skim off carefully.

Fifth:—After the Lard has settled for three hours all the water will be at the bottom. If the kettle is provided with a faucet at the bottom so the water can be let off, let the water run out slowly until it is all drained out; if the kettle has no opening in the bottom, skim the Lard off from the top of the water and place the Lard in a Lard Cooler. If you have a Lard Cooler with an Agitator, start the Agitator and keep it running until the Lard gets thick like cream; it is then ready to run off into buckets. If you have no regular Agitator, it is necessary to stir the Lard by hand occasionally until it gets thick and creamy; stir it as much as possible until it gets thick, and then run it into buckets.

IF ONE HAS A LARD SETTLING TANK AND AN AGITATOR, HANDLE THE LARD AS FOLLOWS:

A Packer or Butcher who makes any quantity at all of Kettle Rendered Lard, should have a Rendering Kettle in which the Lard is rendered, a Settling Tank in which the Lard is settled, and a Lard Cooler with an Agitator in it. The Lard Cooler and Agitator should be double-jacketed, so that cold water can be run into the jacket to cool the Lard.



COOLER AND AGITATOR

When equipping a plant with a Settling Tank and Cooler, we advise that the Settling Tank have two faucets in it; one at the extreme bottom and the other about one inch from the bottom. Then, when the water is drawn off of the Settling Tank, it should be drawn off from the lowest faucet, and when the Lard is drawn off into the Agitator, it should be run off through the faucet which is an inch from the bottom. In this way, small particles which may be in the Lard will remain in the bottom of the Settling Tank, in the one inch layer of Lard which remains in the bottom of the Settling Tank. After all the Lard is run off through the upper faucet, what remains between the upper faucet and the bottom of the Settling Tank should be drawn off through the lower faucet and should be kept until the next time Lard is rendered, and then should be re-rendered with the next batch.

After the Lard has been rendered and has been treated in the Rendering Kettle, with the Lard Purifier, strain it through a cheese cloth into the Settling Tank, allow it to settle for two hours, then draw off all the water from the bottom faucet. After the water has been drawn off, draw off the Lard from the top faucet and again run it through cheese cloth, into the Cooler and Agitator. Start the Agitator and allow it to run until the Lard is thick and white, like cream, and then run it off into buckets or tubs.

A good way to set up the Settling Tank and the Cooler and Agitator, is to have the Settling Tank high

enough up, on a bench above the Agitator, so that the Lard can be run out of the Settling Tank into the Agitator. The Cooler and Agitator should also be high enough from the floor so the Lard can be run from it into buckets or tubs.

It costs very little to properly equip oneself with the proper apparatus, and if properly rigged up it is a pleasure to make the Lard and requires very little work.

LARD NOT PURIFIED.

If Lard is made without taking out the impurities with water and our Lard Purifier, the Lard will become rancid if it is to be kept during the hot weather, and it will not be so sweet in flavor nor as clean and white as it is when treated with our Purifier according to the preceding directions. Our Lard Purifier neutralizes the free fatty acids in the Lard, thus to a considerable extent preventing rancidity and helps keep the Lard Sweet and Pure.

Lard made with our Lard Purifier according to the foregoing directions will comply with the regulations under the various Pure Food Laws.

COMPOUND LARD.

In the Southern States, where the climate is warm, it is necessary to add either Tallow or Tallow Stearin or Lard Stearin to Lard, so as to stiffen it in order that it can be handled at all.

To make Compound Lard, first render the Lard and press out the cracklings as directed; then add from 10 to 20 per cent of either Tallow, Tallow Stearin or Lard Stearin and stir until it is all melted and thoroughly mixed with the Lard. The quantity of Tallow or Stearin to add depends upon the climate and season of the year, and also the price of the different materials.

After adding the above, purify the mixture, the same as directed for handling Pure Lard. However, Compound Lard must always be agitated until it is thick and cream-like before it is run into buckets. If one has no Lard Agitator, it must be stirred by hand until it is stiff and cool.

It is perfectly legal to add Tallow, Tallow Stearin or Lard Stearin to Lard for this purpose, but such Lard must be sold as Compound Lard. It cannot be sold as "Pure Lard" when these ingredients are added to it.

COTTON SEED OIL-LARD COMPOUNDS.

For certain purposes Cotton Seed Oil added to Lard is preferred to straight Lard, and the Cotton Seed Oil is added after the Lard has been purified and is ready to put in the Agitator.

To make a really good Compound Lard, a Cooler with an Agitator is absolutely necessary, but if one hasn't a cooler with Agitator, it can be done by stirring by hand continuously, so the Lard and Oil do not separate while cooling.

When Cotton Seed Oil is used, it must be Refined Cotton Seed Oil, and the more it is refined the better the compound will be. Lard should always be run through cheese cloth before putting it in the Lard Cooler, so as to take out any small particles of detached cracklings which may remain in the Lard.

The formula for making Compound Lard with Cotton Seed Oil varies according to the relative values of the ingredients and the quality of Compound desired. The usual Compounds found on the market, as sold at the present time under trade names, and which contain no Lard at all, are made of 80 per cent Cotton Seed Oil and 20 per cent Tallow Stearin. (Tallow Stearin is Tallow with the oil pressed out of it.) A small butcher can make this Compound by using 80 per cent Cotton Seed Oil and 20 per cent Rendered Tallow, which has previously been purified with B. Heller & Co.'s Lard Purifier.

If it is desired to make a better quality of Compound, use less Cotton Seed Oil and add sufficient Lard to bring the cost and quality to the desired degree.

All such Compounds must be sold as "Compound Lard" when Lard is added; but when no Lard is added, they must be sold as "Lard Substitutes." These preparations are perfectly legal, and comply with the Pure Food Laws provided they are labeled and sold for what they are, but no one should make a Lard Compound or Imitation Lard and sell it for Pure Lard.

REFINING LARD WITH FULLER'S EARTH.

THE METHOD USED FOR REFINING LARD IN LARGE PACKING HOUSES.

The large packers all refine Lard and Tallow with the Fuller's Earth process, and for the benefit of the small packers, who would like to know how it is done, we will give the full directions, although a small packing house can hardly afford to put in a plant for the process, as it requires a man who is experienced to refine Lard and Tallow in this manner. If a packing house does not make enough Lard and Tallow to afford to keep a man especially for this purpose, it will not pay to put in a refinery, which consists of the following machinery: A Receiving Kettle, which is a large open tank with steam coils in it to dry the Lard or a large Jacket Kettle will do. A Clay Kettle, which is a tank with steam coils in it for heating the Lard and an air pipe at the bottom of it connected to an air compressor. A Lard Cooler with Agitator to cool and stir the Lard while it sets so as to have it thoroughly mixed. A Pump, Air Compressor and Filter Press. An ordinary size outfit will cost from $2,000 to $3,000.

First, the Lard, Tallow or Cotton Seed Oil, which is termed stock, is placed in the Clay Kettle. The Clay Kettle is simply an iron jacket with a coil in the bottom of it through which air is pumped. In this kettle, the Fuller's Earth is added. To each and every 100 lbs. of stock, there is added from one to two lbs. of Fuller's Earth; the quantity depending upon the grade of stock. Before the stock is treated a small test is made as follows. A small quantity is heated; in a part of it one per cent of clay is put, in another part 1½ per cent, and in another two per cent. Mix each lot thoroughly, put them into a funnel over filter paper and allow them to filter. By examining these samples, one can tell how much earth to use to the stock in the kettle. This must be done when the stock varies. Of course, when the Lard, Tallow, or Oil are running uniform, it is not necessary to make the test, but where the stock changes, it is always advisable to test before treating, for the reason that too much Fuller's Earth put into the stock will give the Lard an objectionable flavor. Before stock of any kind can be treated with

Fuller's Earth, all the moisture must be out of it; Lard usually contains two to three per cent of moisture, and very often considerably more, so it must be heated in a Jacket Kettle until all the water is evaporated. If there is any water in the Lard, the Fuller's Earth attacks the water first, and the Lard is not affected, because wet Fuller's Earth has absolutely no effect upon Lard. When the Fuller's Earth is added to Lard, it must be 155 degrees hot; Tallow must be 185 degrees hot, and Cotton Seed Oil 140 degrees hot. After the desired heat is obtained, regulate the steam so the temperature will remain stationary, turn on the air, and when it is blowing hard, put in the Fuller's Earth and blow for about 20 minutes; then start the force pump and pump the stock through the Filter Press. If the stock is of fine quality and only a small percentage of Fuller's Earth is used, it can be pumped directly into the Receiving Kettle, but if a large percentage of Fuller's Earth is used, it is advisable to let the Lard run back into the Clay Kettle, and keep on letting it run through the filter and pumping it round until it is thoroughly clarified; then allow it to run into the Receiving Kettle.

If inferior stock is used, sometimes as much as four and five per cent of Fuller's Earth is used to refine it, but it is not advisable to use that large amount as the clay gives off an odor which the stock sometimes absorbs. Always use the least amount of clay that good judgment indicates will do the work, and after pumping through the filter, if it is not as it should be add more clay and refilter it.

To make Compound Lard, treat the different stocks separately, run them in different tanks, and then mix them. After they have been put into the receiving tank or the mixing tank, it is advisable to mix them by blowing air into the bottom of the kettle in which are Lard, Tallow and Oil; this will mix even better than any process or method that we know of. The amount or kind of stock to be used depends upon the season of the year, and the kind and quantity of goods you wish to make. Equal parts of Tallow, Lard and Oil make a very good Compound. All the cloths for the Filter Press should be washed every day after using them as they must be kept perfectly clean; the cleaner the better.

After the Compound Lard has been thoroughly mixed it must be put into an Agitator and agitated until it is thick like cream before it is run off into buckets.

HOW TO RENDER TALLOW WHITE, ODORLESS, FLAKY AND SOFT, LIKE LARD IN TEXTURE

It is an easy matter to render Tallow so it will have a very light color, in fact, will be almost white and at the same time flaky and soft like Lard, if the instructions which follow are carried out. When so rendered, the Tallow will sell at a good price, as it will be entirely free from a tallowy odor, and is an excellent thing for baking purposes. Tallow rendered according to these instructions can be mixed with Lard and it will even improve the Lard. But it must be sold for what it is.

Take Beef Suet and all the Beef Fat trimmed from steaks and other cuts, and run it through a Chopper, chopping it very fine. It will thus become soft and sticky so it can be rolled in small balls about one and one-half to two inches in diameter. While this is being done, fill Rendering Kettle half full of water, dissolving in the water about two ounces of Lard Purifier to every 100 lbs. of Tallow to be rendered, and start it to boil. While the water is boiling the small balls of Tallow should be placed on top of the water until a sufficient number of balls have been thus put into the water to make a layer three or four inches deep, but not deeper. After the Tallow is rendered out of the balls, the heat should be turned off and the Tallow should be permitted to cool. Just as soon as the boiling has ceased, all the cracklings that are on the surface should be skimmed off, put into a press and pressed out. The Tallow that is on the surface should be skimmed off and put into buckets. Care should be taken that no water is taken out with the hot Tallow. The tallow which remains on the water can be left there until it is hard, when it can be taken off and melted if desired, and then run into buckets. The advantage in rendering Tallow in this manner is to prevent the Tallow from becoming too hot, and thus to keep it from turning dark; besides, the water and Lard Purifier purifies the Tallow and also draws out the tallowy odor.

Any butcher can build up a large trade on home-rendered tallow when it is prepared in this manner. In fact, his trade will like the Tallow so well that he will not be able to supply the demand. As a rule, the butcher sells his Tallow unrendered at a low price, but if he will render it himself and follow the above instructions carefully, he can sell the Tallow for at least 10 to 12 cents per pound, owing to the fact that Tallow rendered in this manner produces a very fine fat for cooking purposes. We believe it is much better than Lard.

NEAT'S FOOT OIL.

Neat's Foot Oil is made by simply boiling the feet of cattle in a water bath, in an open kettle. The oil will come out of the feet and float on the top of the water. After the oil has been cooked out of the feet, they should be skimmed out of the kettle. The oil should then be treated with our Lard Purifier, the same way as directed for treating Lard. Simply let the water and fat cool down to 200 degrees Fahrenheit or below, and to every 100 lbs. of oil add about four ounces of our Lard Purifier dissolved in a quart of water. Stir the water, Lard Purifier and Neat's Foot Oil thoroughly, and then start up the fire and bring it to a boil. Skim off any foam and impurities that may come to the surface and then stop the fire and allow it to settle about two hours; then skim the oil off of the top of the water and you will have genuine, sweet and refined Neat's Foot Oil.

KILLING ON THE FARM.

Very often butchers in the smaller towns find it convenient to slaughter live stock in the country where it is purchased. In order to meet such cases we submit the following directions for slaughtering cattle, hogs and sheep, and no doubt they will be found useful and suggestive.

It is absolutely necessary that only healthy animals shall be slaughtered for food. It is not so important that stock should be fat, although no one can expect the best results from lean animals, but as there is a demand for all grades of meat, condition is not so exacting as health.

In the case of injured animals, crushed ribs, broken limbs, etc., the flesh is not good for food unless the stock has been slaughtered immediately upon receiving the injuries.

AGE FOR KILLING.

It is a well known fact that the meat of old animals is tougher than that of young ones. The flesh of young animals frequently lacks flavor and is not solid. An old animal in proper condition and good health is preferable as food to a younger one in poorer condition.

Cattle if properly fed are fit for beef at 12 to 24 months, although the meat from these animals often lacks flavor, especially if they have not been well fed. The best meat is from aged steers 30 to 40 months old. A calf should not be slaughtered under four weeks and is not at its best until about eight weeks of age. There is a law in many States confiscating veal offered on the market under six weeks of age.

Pigs may be used after six weeks but the most profitable age at which to slaughter hogs is between eight months and one year.

Sheep may be used at from 3 to 4 months of age; but are at their best from eight to twelve months.

PREPARING FOR SLAUGHTER.

Experience dictates that an animal intended for slaughter should be kept from eating for twenty-four to thirty-six hours before killing. If kept on full feed the system is gorged and the blood, loaded with assimilated nutrients, is pumped to the extremities of the capillaries. It is impossible to thoroughly drain the blood from the veins when the animal is bled, and the result will be a reddish-colored, unattractive carcass. Again, food in the stomach decomposes very rapidly after the animal is slaughtered. Where the dressing is slow, as it must be on the farm, the gases generated from the stomach often flavor the meat. It is well to give water freely up to the time of slaughter as it aids in keeping the temperature normal and helps in cleaning out the system, resulting in a nicer colored carcass.

It is but natural that the condition of animals prior to slaughter should have a positive effect on the keeping qualities of the meat. There should be no excitement sufficient to raise the temperature of the body. Excitement creates fever, prevents proper drainage of the blood vessels, and, if intense, will cause souring of the meat very soon after dressing. No animal should be killed after a long drive or rapid run about the pasture. It is always better in such cases to permit the animal to rest over night rather than to risk spoiling the meat. The flesh of an animal that has been overheated and then killed is usually of a dark color and frequently develops a sour odor within a few hours after dressing. Bruises cause blood to settle in the affected portions of the body, often causing loss of a considerable part of the carcass. A 24-hour fast, ample water, careful handling and rest are necessary in order that the meat may be in the best condition for immediate use or curing.

KILLING AND DRESSING CATTLE.

The first step in killing is to secure the animal so that, in no emergency, it can escape. Use a rope one inch in diameter. Put a slip noose in one end with a knot just far enough from the noose to prevent choking when drawn tight, but it should at the same time allow the noose to draw tight enough so that there is no danger of escape, in the event of the rope becoming slack. If the animal has horns, pass the noose over the head, back of the ear and horn on the right side, but in front of the horn on the left side of the head. This operation leaves the full face of the animal bare and does not tighten on the throat. When a dehorned or polled animal is to be slaughtered it will of course be necessary to put the noose around the neck. Attach an ordinary pulley to a post or tree close to the ground, to the barn floor or sill, pass the rope through it and draw the animal's head down as close to the pulley as possible.

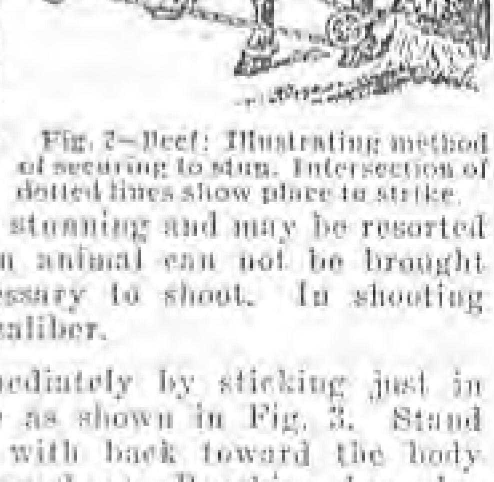


Fig. 2—Beef: Illustrating method of securing to stun. Intersection of dotted lines show place to strike.

Administer a heavy blow in the center of the forehead at a point where lines from the base of the horns to the eyes would cross. Shooting has the same effect as stunning and may be resorted to. Frequently where an animal can not be brought to the pulley it is necessary to shoot. In shooting use only a rifle of good caliber.

Bleed the animal immediately by sticking just in front of the breast bone as shown in Fig. 3. Stand in front of the animal with back toward the body after the manner of a horseshoer. Reaching down between the front feet, lay open the skin from breastbone toward the chin for a distance of 10 to 12 inches, using the ordinary skinning knife. Insert the knife with the back against the breastbone and the tip pointing to the spinal column at the top of the shoulders, cutting just under the windpipe and about 5 to 6 inches in depth at the junction of the jugular vein near the collar bone; at this point if the vein is severed the blood will run out rapidly. If stuck too deep, the pleura will be punctured and blood will flow in the chest cavity, causing a bloody carcass. It requires practice to become expert in the sticking of beef. Not so much skill is required to simply cut the animal's throat back of the jaws but the time required for bleeding is very much longer and the bleeding less thorough.

SKINNING AND CUTTING.

Begin skinning at once while the carcass is lying on its side by splitting the skin through the face from the head to the nose as shown in Fig. 4. Skin the face back over the eyes on both sides and down over the cheeks, cutting around the base of the horns so as to leave the ears on the hide. Split the skin down the throat to meet the cut made in bleeding. Start the skin in slightly on the sides of the neck and down to the jaws. Now remove the head by cutting just back of the jaws toward the depression back of the head as shown in Fig. 5. The atlas joint will be found at this point and may be easily unjointed with the knife.

Fig. 3—Beef: Place to stick and manner of sticking.

At this point the carcass should be rolled on its back and held in position by a small, strong stick, say 18 inches long, with a sharp spike in both ends. Insert one end in the brisket and the other in the floor or ground. This will hold the carcass in position. Then split the skin over the back of the four legs from between the dew-claws to a point three or four inches above the knees. Skin around the shin and knee, unjointing the knee at the lowest joint as seen in Fig. 6 and skin clear down to the hoof.

The brisket and forearms should not be skinned until after the carcass is hung up. Now cut across the cord over the hind shin, splitting the skin from the dew-claws to the hock up over the rear part of the thigh to a point from four to six inches back of the cod or udder. Skin the hock and shin, removing the leg as shown in Fig. 7. In splitting the skin over the thigh turn the knife down flat with the edge upward to avoid the cutting of flesh. While the hind leg is stretched ahead it is skinned down over the rear of the lower thigh but do not skin the outside of the thigh until the hind-quarters are raised. After the legs are skinned split the skin of the carcass over the midline from the breast to the rectum.

Fig. 4—Beef: Skinning the face, illustrating manner of starting.

Fig. 5—Beef: Removing the head.

Now begin at the flanks and skin along the midline until the side is nicely started. With a sharp knife held flat against the surface have the hide stretched tightly and remove the skin down over the sides with steady down-strokes of the knife, as shown in Fig. 8. But it is necessary that the hide should be stretched tightly and without wrinkles. Care should be taken to leave a covering of muscles over the abdomen of the carcass as it keeps it better. In siding the beef, it is usual to go down nearly to the back bone, leaving the skin attached at thighs and shoulders; skin over the buttock and as far down on the rump as possible, always avoiding cutting the flesh or tearing the membrane over it. A coarse cloth and a pail of hot water should be at hand while skinning and blood spots wiped quickly from the surface, but the cloth should be nearly dry, as the less water used the better. Open the carcass at the belly and pull the small intestines out at one side. Use a saw or sharp ax in opening the brisket and pelvis. After raising the windpipe and belly and cutting loose the pleura and diaphragm along the lower part of the cavity, the carcass will be ready to raise.

Fig. 6—Beef: Showing manner of unjoining fore leg and skinning shank.

Fig. 7—Beef: Unjointing the hind leg.

Fig. 9 shows the carcass ready for raising, and Fig. 11 shows the block and tackle rigging attached to the carcass about to be raised.

When the carcass is raised to a convenient height, skin the hide over the thigh, rump and hips. While in this position, it is well to loosen the rectum and small intestines and allow them to drop down over the paunch. The fat lining, the pelvis and the kidney fat should not be disturbed nor mutilated. The intestines may be separated from the liver to which they are attached by the use of a knife. The paunch is attached to the back at the left side and may be torn loose. Let it roll on the ground and cut off or draw off the gullet. The carcass at this point is shown in Fig. 11. Now raise the carcass a little higher and take out the liver, having first removed the gall bladder. Now remove the diaphragm, lungs, the heart, and finish skinning over the shoulders, forearms and neck, as shown

Fig. 8—Beef: "Siding down;" knife held flat against the tightly stretched skin.

in Fig. 12. Sponge all the dirt and blood off with a cloth, split the carcass in halves, using a saw, cleaver or sharp ax, wash out the inside of the chest cavity and wipe it dry.

Fig. 9—Beef: Ready to raise: Breast, forearms and neck, left covered to protect the meat until the carcass is raised.

Trim off all bloody veins and scraggy pieces of the neck and leave the beef to cool before quartering.

Fig. 11—Beef: Removing paunch and intestines.

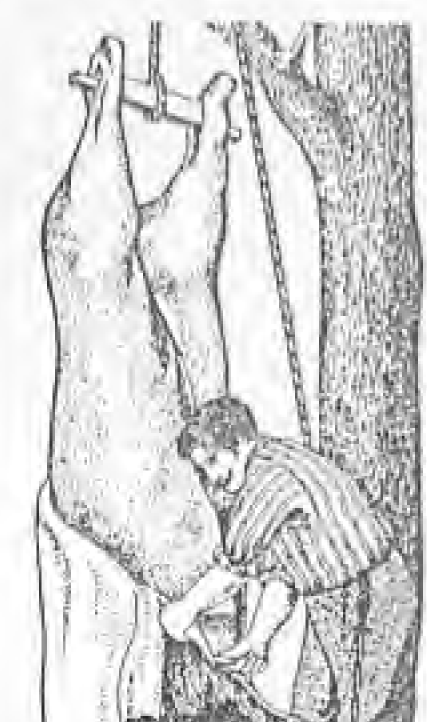
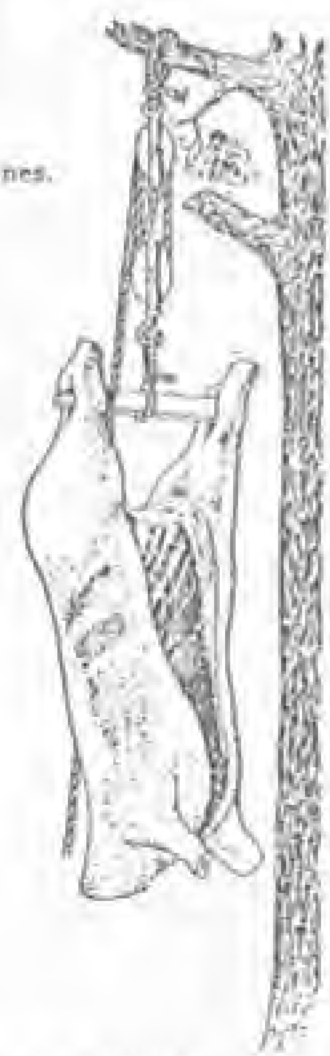


Fig. 12—Beef: Skinning shoulders and forearms.



13.—Beef raised out of the way of animals to cool.

Fig. 13 shows the finished carcass hanging high up and cooling.

KILLING AND DRESSING MUTTON.

If the sheep is an old one, it should be stunned. If a young one, dislocating the neck after cutting the throat serves the same purpose. This is accomplished by placing one hand on top of the head, the other under the chin, and twisting sharply upward. Lay the sheep on its side on a platform, with its head hanging over the end. Grasp the chin in the left hand and stick the knife through the neck back of the jaw, turning the cutting edge of the knife toward the spinal column and cut the flesh to the bone. By so doing it is impossible to cut the windpipe. (See Fig. 14.)

Fig. 14—Manner of Sticking a Sheep.

Split the skin over the back of the front leg from the dewclaws a little above the knee. (See Fig. 15.) Open the skin over the windpipe from breast to chin, starting in slightly on the sides of the neck. Split the skin over the back of the hind leg through the middle line and skin the buttock. Raise the skin over the udder or cod and flanks. Skin around the hocks and down to the hoofs, cutting off the feet at the toe joints. Run the knife between the cord and bone on back of the chin and tie the legs together just above the pastern joint. Do not skin the legs above the hock until the carcass is hung up.

Fig 15.—"Legging out" a sheep.

Hang the sheep up by the hind legs, split the skin over the middle line; start at the brisket and ''fist off'' the skin. This is done by grasping the edge of the pelt firmly in one hand, pulling it up tight and working the other with the fist closed between the pelt and the body, over the fore-quarters downward and upward and backward over the hind-quarters and legs. It is unwise to work down on the skin over the hind legs, as it would rupture the membrane. The wool should always be held away from the flesh as a matter of cleanliness, and the skin on the legs should be pulled away from the carcass rather than toward it. When the pelt has been loosened over sides and back, it should be stripped down over the neck and cut off close to the ears. Remove the head without skinning by cutting through the atlas joint.

Fig. 16—Fisting off the Pelt.

GUTTING.

Remove the entrails by cutting around the rectum and allowing it to drop down inside, but do not split the pelvis. Open down the belly line from cod or udder to breast bone; take out the paunch and intestines, leaving the liver attached to the diaphragm. It is not best to split the breast. Reach up in the pelvis and pull out the bladder. Wipe all blood and dirt from the carcass with a coarse cloth wrung dry from hot water. Double up the front legs and slip the little cord found by cutting into the fleshy part of the forearms into the ankle joints.

Fig 17.—Removing the intestines of sheep.

KILLING AND DRESSING HOGS.

A good sticking knife, hog hook, scrapers, a barrel or a trough for scalding, and a convenient place for working are the important necessities. Set the barrel at the proper slant with the open end against a table or platform of the proper height, with the bottom securely fastened; a strong tackle built for the purpose is desirable, but not necessary. Hogs should not be excited or heated, and in catching and throwing them bruising must be avoided. However, it is not necessary to stun hogs before sticking them. At slaughter houses they are usually hung up by one hind leg. If there is no hoisting appliances, lay the hog on its back and hold it there until stuck. Two men can handle a hog if they will but work with intelligence. By reaching under the animal, one at the fore leg and the other at the hind leg, they can turn a heavy hog on its back easily. One man, standing astride the body, with his feet close against the side and holding its front feet, can control it while the other does the sticking.

Fig. 18.—Manner of holding and sticking a hog.

Fig 19.—Scalding a hog. Note arrangement.

The knife should be eight inches long, straight bladed and narrow, and stuck into the hog's throat just in front of the breast bone, the point directed toward the root of the tail and held in line with the back bone. This is necessary to prevent cutting between the ribs and the shoulders, which would cause the blood to settle there with waste in trimming of the shoulder. When the knife has been stuck in six or eight inches, according to the size of the hog, turn the knife quickly to one side and withdraw it. The arteries that are to be cut run close together just inside of the breast bone and both are cut when the knife is turned, providing the edges are sharp at the point.

The water for scalding when heated in the house should be boiling when removed from the stove. If put into a cold barrel it will be about the right temperature when the hog is ready for scalding. During the scalding process the water should be about 185 to 195 degrees, if the scalding tub holds only enough water to scald one hog. Water at 150 degrees will scald a hog, but, of course, more time is required. In large packing houses where a large tub is used and steam is continually blowing into the water, the water is kept at 150 degrees. Too hot water is likely to cause more trouble than too cold, and for this reason it is always best to have a thermometer at hand. Of course, the temperature may be reduced by putting in a little cold water. A hog should not be scalded before it is dead or the blood in the small blood vessels near the surface of the skin will cook and give a reddish tinge to the carcass.

To make the hair easy to remove and to cleanse the skin of the hog and free it from all the greasy filth which forms a scurf on the skin of all hogs, our Hog-Scald should always be used. Hogs scalded with the aid of Hog-Scald do not require so much heat to loosen the hair, it requires much less labor to clean them, and the dressed hogs will look much nicer and the rinds will cure and smoke nicer than when it is not used. No Farmer or Butcher will dress his hogs without Hog-Scald after giving it a trial.

While being scalded the carcass should be kept moving constantly to avoid cooking the skin. While scalding, the hog should occasionally be drawn out of the water for air, when the hair may be tried. When both hair and scurf slip easily from the skin, scalding is completed. Remove the carcass from the water and begin scraping. The head and feet should be cleaned first, as they do not clean easily when cold.

Use a "candlestick" scraper on the head. Use the hands and a knife if you haven't this tool. The feet and legs are easily cleaned by grasping them firmly with the

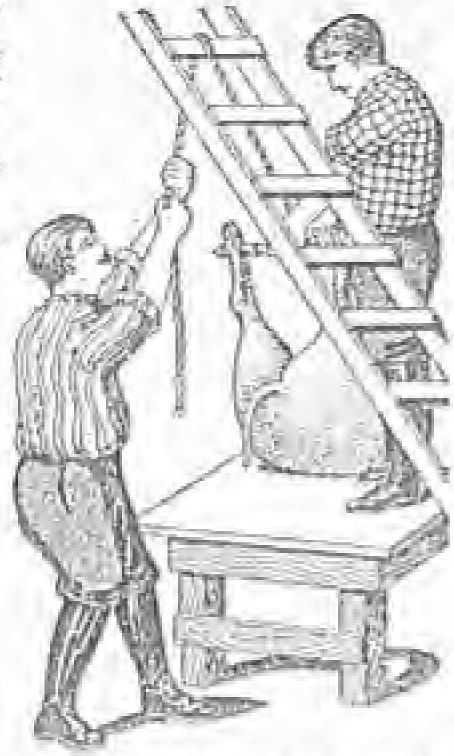


Fig. 20—A convenient way of hanging up a hog.

hands and twisting them around and back; pull the little bristles of the body by hand and remove the scurf and fine hair with the scraper, long corn knife or other tool. Wash the entire carcass with hot water and shave it with a sharp knife. Insert a stick under the gambrel cords and hang up the hog.

Wash down with hot water, shave patches and rinse with cold water. Occasionally the hog is too large to scald in a barrel. Cover it thickly with blankets or sacks containing a little bran, pour hot water over it and the hair will be readily loosened.

GUTTING HOGS.

Split the hog between the hind legs, separating the bones with a knife. Run the knife down over the belly line, guiding it with the right hand and shielding the point with the fingers of the left hand and thus avoid the danger of cutting the intestines. Split the breast-bone with a knife or an ax and cut down through the sticking place to the chin. Cut around the rectum and pull down until the kidneys are reached, using a knife whenever necessary to sever the cords attached to the back. Do not disturb the kidneys or the fat covering them, excepting in warm weather, when the leaf may be removed to allow quicker and more thorough cooling. Remove the paunch and the intestines. The gall bladder lies in plain sight on the liver, and it lies attached to the diaphragm and hypatic vein. It should be stripped off after starting the upper end with a knife. Avoid spilling the contents on the meat. Insert the fingers under the liver and strip it out. Cut across the artery, running down the backbone, and cut around the diaphragm, removing them with the pluck, that is, heart, lungs, liver and gullet. Open the jaw and insert a small block to allow free drainage. Wash out all blood with cold water, and dry with a coarse cloth. In hot weather the backbone should be split to facilitate cooling. The fat should be removed from the intestines before they get cold. It is strong in flavor and should not be mixed with the leaf lard in rendering.

Gutting the Hog

CLEANING CASINGS.

Those who undertake to clean casings have great trouble in getting them white and many resort to lime and other methods for both bleaching them and freeing them of fat. Notwithstanding all such efforts, the casings remain dark and unattractive. The reason for much of this difficulty lies in the fact that the casings are not properly washed and cleaned in the first operation. Casings should be washed thoroughly in three different changes of water. The fat should then be scraped off from the outside. Water must also be run through the casings and they should be turned inside out so that they may become thoroughly washed and cleaned. After casings have been perfectly washed and scraped in this manner, they should be dry-salted by packing them in a liberal quantity of salt. Casings thus cured will remain sweet and white.

HANDLING HIDES.

The proper handling of the hides of slaughtered animals, so as to obtain the best possible prices for them and avoiding excessive shrinkage before they are marketed, is a very important matter and should have the Butcher's careful attention.

In the first place, it should be borne in mind that it is an easy matter to badly damage the hide of an animal before killing by prodding it with a pole. This

of course should always be avoided.

The killing floor should be kept as clean as possible. If there is blood on the floor and this gets on the hair and remains there, when the hides are stacked up this blood comes in contact with the fleshy side of the hide next to it and will make a spot which gives the hide a very bad appearance. By keeping the hides entirely free from blood, they make a better appearance and bring a better price.

The greatest care should be given to the removal of the hide, so they are not scored, as this greatly reduces the value of the hides to the tanner. A good, careful skinner is worth several dollars a week more to the Butcher who kills many animals than a skinner who is careless in his work. (The hide should be so nicely removed from the animal that when it comes to the tanner it should look like it had been planed from the animal, it should be so so free from cuts or scores.)

PROPER STORAGE OF HIDES.

This is a point of very great importance. If many hides are kept on hand for any length of time before shipment, the difference in shrinkage between hides which are properly kept and those which are not so stored is very great. The careful storing and handling of hides will always repay the time and trouble necessary, not only in the weight of the hides, but in the condition in which they are marketed.

Hides should be kept in as cool a room as possible and all windows and doors should be kept closed, so as to have no circulation of air.

SALT TO USE IN SALTING HIDES.

The best salt to use for this purpose is Crushed Rock Salt. Large lumps of salt are objectionable, on account of leaving indentations in the hides where they are pressed together, which injures their appearance in the eyes of the buyer.

One part of Fine Salt to three parts of Crushed Rock Salt makes a fine mixture for salting hides, as the fine salt quickly dissolves and makes a moisture on the hide, which the hide absorbs.

When re-using old salt for salting hides, always add about one-third of new salt to it, as this gives much better results. About one-third of the salt used is consumed in salting hides, so by adding one-third additional of fresh salt each time, the supply of salt is kept the same. Always keep the salt as clean as possible. If there is much dirt or manure in it these will discolor the hides and they will not make as good a showing to the buyer.

QUANTITY OF SALT TO USE ON HIDES.

In large Packing Houses about 35 lbs. of salt is used for each hide. The Packers find that by using this quantity they get better results than if a smaller quantity is used. Very few Butchers in the country use as much salt as this on their hides, but they would find it greatly to their advantage to use about 100 lbs. of salt to every three hides, and if the proper quantity of salt is used, as described in the foregoing, it can be used over and over again with a loss of about one-third for each time used. It is much better for the Butcher to invest more money in salt and give the hides a proper amount, as he will thus save on the excessive shrinkage of the hides, which would amount to more than the cost of the salt.

HOW TO STACK HIDES WHEN SALTING.

One of the most important features in salting hides is the way they are stacked when salted. The hides must be so piled that they are perfectly level and the salt must be distributed over every part of the hide. The flesh side should be up, and the salt should be rubbed over them evenly. The hides can be piled about two feet high. The legs of the hide should be kept straight and flat, so the salt gets into all crevices. The edges of the stack of hides should be kept a trifle higher all around than the center of the stack, so the natural moisture that comes out of the hide and the dry salt will remain on them. If the hides are salted on a slanting floor, or if the hides are piled up carelessly so the hides lie slanting, the brine composed of moisture of the green hide and the salt will run off and then the percentage of loss from shrinkage will be large.

HOW LONG TO CURE HIDES.

Hides should lie in the pack and salt for 25 to 30 days, so as to be fully cured and ready for shipment.

TRIMMING OF GREEN HIDES.

Before the hides are salted the switches should be cut off of the tail and all loose ends of the hide should be cut off. The butt of the ears should also be split; if the hides go into the pack without attention to this point, it makes the pack very uneven on account of the thickness of the ear, and the salt does not have a chance to properly penetrate the ears, and they are liable to spoil. Loose pieces of meat that are carelessly left on the hides and all excessive fat should be trimmed off. Hides must not be salted until five hours or longer after the animal is killed, and they must not be piled closely, as this would prevent the animal heat from escaping. If hides are salted with the animal heat in them, very often the hair will slip, which will make No. 2 hides.

SALTING SWITCHES.

Switches should be spread out on the floor so they will thoroughly cool off. After they are thoroughly cool, they can be piled into a heap and salt applied so they are entirely covered. The more salt put over them the better, as they spoil very easily.

TANNING SKINS.

Butchers can easily tan the skins of Sheep, Goats, Cattle and Calves with Tanaline, and they can often pick up fine skins of wild animals, which can also be easily tanned. By tanning the fancy skins that the Butcher frequently can get, he can sell them for

three or four times as much as he would realize when sold to the Hide Buyer.

DIRECTIONS FOR TANNING SKINS.

First:—After weighing the skins, soak them in plain cold water; fresh or salted skins for 24 hours, and air dried skins for at least 48 hours. Then scrape off all the fat with a dull instrument, such as a putty knife or sharp piece of hard wood. Then wash thoroughly, with cold water, both sides of the skin.

Second:—Use, for every 30 pounds of skins, a 2-pound package of Tanaline and 4 pounds of salt. Dissolve 2 pounds of Tanaline and 4 pounds of salt in 5 to 6 gallons of cold water, and when thoroughly dissolved, place the skins into it. Have sufficient water so that all the skins are entirely covered. Tan small, thin skins in this solution for 24 hours. Goat, sheep, calf and dog skins should be allowed to tan from two to three days, according to their thickness. Cattle or horse skins, or skins of a similar nature, require one week in this solution to properly tan them. During the tanning process remove the skins and replace them in the same solution twice a day, so that the solution gets over all parts of the skins uniformly. After tanning, drain off all the solution that can easily be drained off, and spread the skins out with the flesh side up, away from the sun.

Third:—Make a heavy flour paste; thin enough to spread easily. Now cover the entire flesh side of the skin with a thin layer (about one-eighth inch) of this paste. Let the skins and flour paste dry for two to four days, according to the weather. The paste will absorb the moisture out of the skins and soften them.

Fourth:—When the skins become dry, work them so that the paste is shaken off. If the skins have been allowed to dry too long, they will be too hard to work, and they should be softened by sprinkling some dampened sawdust over the skins and leaving it on them over night. The skins should next be softened and worked by pulling them over the edge of a table or box, until soft and pliable.

POLISHING HORNS.

If the horns are rough, first take a file and file through the rough horn, down to the solid horn, and file the horn into proper shape, smoothing the tip and shaping the large end to suit the fancy. After they have been filed, take sand paper and rub the horn with the sand paper until it is nice and smooth, then finish the rubbing with very fine sand paper, so as to take out all the scratches. After it has been sand papered, take a piece of glass and scrape it until very smooth. Polish by rubbing with powdered rotten stone and machine oil. The polishing must be done with the palm of the hand, and the horn should be rubbed until beautifully polished.

WHY DRIED BEEF DOES NOT THOROUGHLY DRY.

Query.—R. B. writes: "We are having trouble with our Dried Beef. It doesn't seem to dry out. We have it hanging in the cooler."

Ans.—Your beef doesn't dry out because you keep it in the cooler. In order to dry beef, it is necessary to hang it in a dry room. You can hang it right out in the market for that matter and there it will dry rapidly, in fact, it will dry too quickly so that it will become hard. Dried Beef will dry some in the smoke house, but not sufficiently. We send you a copy of our book, "Secrets of Meat Curing and Sausage Making," which will give you full particulars in reference to this entire subject.

BULL-MEAT PREFERABLE FOR SAUSAGE.

Query.—Z. & R. write: There is a prevailing notion among local butchers that bull meat possesses qualities which make it superior to first-class steer or cow meat for making bologna and weiners. Is this not an erroneous idea? How can bologna and weiners be prevented from turning dark and shrinking within a few days after making if exposed to the air?

Ans:—The opinion of your local butcher is correct as far as it concerns bull meat as the best meat for bologna and wienerwurst. The reason for this is that bull meat contains a great deal of gelatine in various forms and far more than even the meat of either steer or cow. If you take the bull meat and chop it up, you will find that it is sticky and binds together, while if you take meat from an aged cow and chop it up it will not bind together, is mushy and soft to the touch, and when cooked frequently crumbles and falls apart.

In answering your next question, we can say that the probable cause in most cases why sausage dries up, shrivels up, shrinks or turns dark within a short time after being made is because it was not properly handled. It is also possible that these effects of which you complain were due to causes produced by the way you salted your meat or what you salted it with. If you will follow our instructions on Bologna making given in our book "Secrets of Meat Curing and Sausage Making," you should have no further trouble. The book is sent free.

HOW TO MAKE A PAPER BAROMETER

Question.—J. K. writes: Can you tell me how a Barometer can be made with paper that tells what the weather is going to be?

Answer.—Paper barometers are made by impregnating white blotting paper in the following liquid, and then hanging up to dry:

Cobalt Chloride	1 oz.
Sodium Chloride	½ oz.
Acacia	¼ oz.
Calcium Chloride	75 gr.
Water	3 fl. oz.

The amount of moisture in the atmosphere is indicated by the following colors:

Rose Red	Rain
Pale Red	Very Moist
Bluish Red	Moist
Lavender Blue	Nearly Dry
Blue	Very Dry

SOUR SAUSAGE

Question.—B. & W. write: We have been using your Bull-Meat-Brand-Flour through all of last winter, and found it satisfactory in every way. We have been using also your Freeze-Em Pickle. Since hot weather began our sausage has soured. We have lost over 150 lbs. of sausage through its souring. Can you tell us what is the probable cause of our sausage becoming sour?

Answer.—We will say that the cause of your sausage souring may be due to several things. Either your grinder has become dull, causing the meat you run through it to heat in the grinding, or it may be due to the fact that the meat was not cold enough to prevent it from heating while being ground.

Another cause for trouble of this kind is in the mixing machine. In mixing meat too much, a considerable quantity of air is forced into the meat, which will often cause it to sour during the warm seasons of the year. During hot weather it is advisable to grind a small quantity of ice with the meat to keep it cold.

We also advise the use of our "A" Condimentine preparation. This is a very useful product for keeping in condition all fresh sausage. It is entirely harmless, containing no substances injurious to health. Complies with all pure food laws.

We are quite positive that you are souring your meat in the grinding, or in the mixing. Please let us know if you have a mixing machine, or whether you mix your meat by hand. If you have no mixing machine you are souring your meat while grinding it. **You should mix ice with your meat before grinding it. Grind the meat and the ice together, and use "A" Condimentine. Your troubles will then disappear.**

SPICED BEEF

Question.—W. C. K. writes: I was very much interested in your magazine "Success With Meat," and wish you would send me a formula for the making and curing of Spiced Rounds of Fresh Beef. In our city we have a great demand for spiced beef and I want the very best formula obtainable, which I know you can furnish me. I have used Freeze-Em-Pickle for a good many years and always get splendid results from its use.

Answer.—We are very glad that you like "Success With Meat," and are pleased to learn you have obtained such uniformly good results with Freeze-Em-Pickle.

To make rolled spiced beef take 100 lbs. of boneless beef plates and cure them in brine made as follows:

5 gallons of cold water.
5 lbs. of common salt.
1 lb. Freeze-Em-Pickle.
2 lbs. of granulated cane sugar.
6 to 8 ounces Zanzibar Brand Corned Beef Seasoning.

Cure the plates in this brine 10 to 20 days in a cooler. The temperature should not be higher than 42 to 44 degrees Fahr., but a temperature of 38 to 40 degrees is better for curing purposes.

The Zanzibar Brand Corned Beef Seasoning gives a delightful flavor to the brine. After the meat has been fully cured in accordance with the above formula sprinkle some Corned Beef Seasoning on the meat; then roll the meat and tie it tight with a heavy string. Some people also like a garlic flavor and if desired a small quantity of Vacuum Brand Garlic may be added to the brine or sprinkled over the meat before it is rolled. Where you want to cure rumps or rounds of beef that weigh from 12 to 25 lbs. each, we advise that you pump them just the same as a ham would be pumped with a pumping brine made as follows:

½ lb. of Freeze-Em-Pickle.
1 lb. of pure granulated sugar.
2 lbs. of salt.
1 gallon of water.

By following the above suggestions carefully you should have no trouble in turning out delicious corned beef.

SOUR HAMS—HOW TO PREVENT.

Query.—F. B. writes: "Have you any chemical compounds that will help us to take care of some sour hams? We have some hams that are just a little sour and thought perhaps you would help us in the matter."

Ans.—We do not prepare anything which would help you in the least. The trouble arises from imperfect curing and the only time that we could have been of help to you would have been when you commenced to put the hams in the pickle; we could have then given you full instructions for pickling the hams in such a way that they could not have soured. In nearly all cases the souring is around the bone. In your case it is best to cut out the bone and trim away the sour meat. After being thus carefully trimmed, they can be rolled, tied and sold for boned hams. You can always avoid the danger of sour hams by exercising extreme care in properly chilling the meat before curing. Most all souring arises from the fact that the meat is not chilled through to the bone. If all the animal heat is thoroughly removed before curing, the hams will come out of the pickle cured all the way through.

If you will follow closely the directions contained in our book, "Secrets of Meat Curing and Sausage Making," you will never have trouble with your hams. We take great pleasure in sending you a copy of this book free of charge.

MAKING SOAP FROM RENDERED FAT

Question.—C. J. B. writes: Can you give me a formula for making soap? I have a surplus stock of rendered fat that I would like to convert into soap.

Answer.—We will give a very good formula for making soft soap and hard soap.

To 20 pounds of clear grease or tallow take 17 pounds of pure white potash. Buy the potash in as fine lumps as it can be procured and place it in the bottom of the soap barrel, which must be water-tight and strongly hooped. Boil the grease and pour it boiling hot upon the potash then add two large pailfuls of boiling hot water; dissolve 1 pound of borax in 2 quarts of boiling hot water and stir all together thoroughly. Next morning add 2 pailfuls of cold water and stir for half an hour; continue this process until a barrel containing 36 gallons is filled. In a week, or even in less time, it will be ready for

use. The borax, and also one pound of resin, can be turned into the grease while the grease is boiling.

Soap made in this manner is a first-rate article, and has a good body. The grease must be tried out, free from scraps, ham rinds, bones, or any other similar kind of matter; then the soap will be as thick as jelly, and almost as clear. To make soft soap hard put into a kettle four pailfuls of soft soap, and stir in it by degrees about one quart of common salt. Boil until all the water is separated from the curd, remove the kettle from the fire and draw off the water with a siphon (a yard or so of rubber hose will answer); then pour the soap into a wooden form in which muslin has been placed. For this purpose a wooden box sufficiently large and tight, may be employed. When the soap is firm turn out to dry, cut into bars with a brass wire and let it harden. A little powdered resin will assist the soap to harden and give it a yellow color. This must be added in the kettle when the soap is boiled. If the soft soap is very thin, more salt should be added.

WHY BOLOGNA DRAWS WATER WHEN IT IS BOILED

Question.—J. B. writes: I again write you for information. When I boiled my bologna the meat drew water. I added the water the second time I ground the meat. Why did the meat draw water while the sausage was being boiled?

I am glad to say that your advice in reply to my last letter enabled me to completely overcome the trouble I had with my corned beef. I am now using the galvanized iron tank as you recommended, and have discarded my old corned beef barrel. I will further say that since I began using your products, that I am selling three times as much sausage as I formerly did. I am greatly pleased with all the goods that I have bought from you.

Answer.—There are three principal reasons for meat drawing water while the bologna is being boiled. The first is that you probably "killed" the meat in the grinding of it, by your knife not being sharp enough, or that your meat soured in the grinding of it by the meat not being cold enough. If you desire to work in some water while grinding the meat, use chipped ice instead of water. The ice will keep the meat cool and stiff, and the meat will not quash, or mash down. The use of ice will prevent the meat from getting warm.

Another cause for bologna drawing water while being boiled is that you have heated the bo'ogna too hot while it was in the smokehouse, or you are boiling bologna at too high a temperature. Boiling bologna at 160 degrees Fahrenheit would hardly spoil it, but we recommend boiling bologna at 155 degrees Fahrenheit.

Possibly you boil the bologna too long. When you take your bologna out of the cooking water do you pour cold water over them? This also has a bearing on the case. Watch carefully all of the above points and you will not have any more trouble. Refer to our book.

OLD BARRELS INFECTED WITH GERMS WILL CAUSE ROPY BRINE

Question.—W. & Sons write: Can you advise us about our corned beef pickle? We made it according to directions given in your book, "Secrets of Meat Curing and Sausage Making." But our brine gets "ropy" as you call it. We use pure cane sugar. We keep our cooler at 38 to 40 degrees Fahr., and are at a loss to know what is the cause of our trouble. Please advise us in this matter.

Answer.—Ropy brine can come about even when pure cane sugar is used in curing. This condition is caused by germs which develop in the brine and cause the brine to thicken. You will find that the barrels which contain your brine are infected with germs. The best way to get rid of these germs is to first empty the barrels; then put the barrels into a vat and boil them. Also scrub the barrels inside and outside. For this purpose they should be rinsed with boiling water to which has been added Freeze-Em, 4 ounces to each gallon, and afterwards a last rinsing with our Ozo washing powder, or soda, in the water that you use for washing the barrels. After the barrels are thoroughly washed and rinsed with cold water, they should then be put out of doors where, the sun can shine upon them and in them for several days before they are again used and placed in the cooler.

Barrels in which corned beef is cured should be made of hardwood. If you are using a syrup barrel or a molasses barrel, you will find that the pores of the wood have become filled with syrup or molasses, which causes the brine to become thick. We think this is the cause of your trouble.

The best barrels to use are tierces that are made of oak, such as lard is shipped in by the packers. The wood of these tierces becomes saturated or filled with lard, and the lard prevents the brine from penetrating or soaking into the wood. Be sure that whatever barrels you use are made of hardwood, and not of white wood or other soft wood, of which many kinds of barrels are made.

HOW TO MAKE FERTILIZER FROM BEEF BLOOD

Question.—J. F. P. writes: Please tell me how to utilize and handle beef blood so as to make fertilizer out of it. I am killing from ten to fifteen head of cattle each week, and thus have quite a quantity of blood.

Answer.—Blood in a packing house is handled as follows: It is first drained from the killing floor into vats and when the vats are filled, live steam is turned on and the blood is boiled until congealed. It is then put in large powerful presses and all the water pressed out, the congealed blood remaining in the press cloth. From the presses it is put through a fertilizer dryer and then is known as dried blood.

Where you only kill 10 to 15 head of cattle a week, it would not pay you to dry the blood in this way. A very fine fertilizer, however, can be made from the blood either for your own use or to sell by boiling the blood in a kettle over a fire or else putting it into a tank and blowing live steam in it; then separate from the water as best you can and mix with black earth, spreading it out thin in the sun to dry. The boiled blood should be mixed with about its own

weight in black earth. This makes a wonderful fertilizer and ought to bring you many extra dollars.

ICE VS. ICE MACHINE IN SMALL PLANTS

Query.—F. S. writes: "I would like to know if an ice machine can be had small enough for a retail meat market and would it be profitable to take the place of an ice box? If you can do so, please give me this information and where I can get the ice machine. Ice here for a summer's use will cost about $75."

Ans.—You state that the cost of ice for the summer season in your market would be about $75.00; therefore, it will not pay you to put in an ice machine, as the cost of operating such a machine for an ice-box would be a great deal more than $75.00 for the season. For instance, if you could obtain electric power or a gas engine for operating the ice machine, you could figure on using at least $7.50 to $10.00 a month for power alone. In addition to this, you would have the expense of repairs and the wear and tear on the machinery, also the cost of ammonia and the interest on your investment. For a small plant, it is always cheaper to use ice for an ice-box, when it is possible to secure the ice at a reasonable figure.

WHAT IS THE DIFFERENCE BETWEEN POTATO FLOUR AND BULL-MEAT BRAND SAUSAGE BINDER?

QUERY.—J. G. Co. writes: Will you kindly state the difference between your Bull-Meat-Brand Sausage Binder and Potato Flour, as we have received several circulars from you on Bull-Meat-Brand Sausage Binder and have always been using potato flour heretofore, and if you will explain to us the difference, and if your Bull-Meat Sausage Binder is better for us, we will be glad to use it.

Answer.—The difference between Bull-Meat-Brand Sausage Binder and Potato Flour is this, potato flour is made from potatoes and the absorbing properties of a pound of potato flour or potato starch are much less than you would imagine. If you will take a gallon of water and put into this water one pound of potato flour and let it stand for one hour, all the Potato Flour will have settled to the bottom and you can pour off the gallon of water and then weigh the pound of potato flour and you will be surprised that it will weigh less than two pounds, it will have taken up less than one pound of water. Also make a test by putting one pound of Bull-Meat-Brand Sausage Binder in a gallon of water and you will find that the pound of Bull-Meat-Brand Sausage Binder will have absorbed almost the entire gallon of water. You can easily see by making this test the difference in the action of the flours when used in different kinds of sausage. When Bull-Meat-Brand Sausage Binder is used it helps to hold the fat and then when the sausage is fried it looks different and tastes different than sausage made with potato flour. Bull-Meat-Brand Sausage Binder absorbs fat and juice in the meat and tends to hold it in the meat and it does not fry out so readily. If you will try the Bull-Meat-Brand Sausage Binder and make a test, you will prefer it to potato flour.

CAUSE OF BOLOGNA DRAWING WATER AND BEING SHORT GRAINED.

Query.—J. L. B. writes: "Will you kindly answer the following questions: First, What is the cause of bologna drawing water while being cooked? Second, What is the cause of short grain bologna?"

Ans.—We do not exactly understand your first question and cannot tell whether you mean that moisture draws out of the Bologna or whether water draws into the Bologna. As a rule, when the Bologna is cooked, especially in water that is too hot, it will shrink very much, become dry and crumble and break up. This effectually answers your second question also. The trouble you are experiencing is due to your method of making Bologna, which is not exactly right. In the first place good Bologna cannot be made without the use of a binder like our Bull-Meat-Brand Sausage Binder. A binder and absorbent of this kind causes the meat to hold together. It also makes the juices of the meat remain in the Bologna. When Bologna does not properly bind, it shrinks up and gets watery inside. This is owing to the fact that the meat does not hold together properly and the water instead of being absorbed right into the meat as it should be, gets between the small particles of meat and separates inside. This is owing to the fact that the meat does not hold together properly and the water, instead of being absorbed right into the meat as it should be, gets between the small particles of meat and separates them. If you will use our Bull-Meat-Brand Sausage Binder and follow the methods set forth in our book, "Secrets of Meat Curing and Sausage Making," you will never have any trouble from your Bologna breaking up or getting crumbly or watery as you call it.

CAUSE OF LARD FOAMING WHEN USING LARD PURIFIER.

Query.—W. & Son write: "Will you kindly tell us what, in your opinion, accounts for our lard foaming after treating it with your B. Heller & Co.'s Lard Purifier when placed in the frying pan? Our customers are complaining about this feature, although the lard is nice and satisfies them in every other respect."

Ans.—The complaint which your customers make concerning the foaming and spluttering of the lard is in all probability due to the fact that all the water was not separated from the lard after treating the lard. Whenever lard is treated with our Lard Purifier, it must be heated hot enough and allowed to stand long enough so that all the water separates and settles out to the bottom. If this is always done, the lard will not splutter when used in the frying pan.

HOW TO CONSTRUCT A MODERN SMOKE HOUSE.

Query.—The S. P. Co. asks: "Would you kindly tell us, and we will gladly pay you for the information, how to construct a modern, up-to-date smokehouse?"

Ans.—We will be very glad indeed to tell you all about this subject without charging you any fee. We are always glad to tell customers or prospective customers how they can profitably conduct their business and make money. As you are located in California, where the weather is always warm, the building of a smoke house becomes simple, because the smoke house will not sweat like it does in a climate where the weather gets cold in winter. Here in the Middle West, or farther East, it is more difficult to get a good color on meats smoked in a smoke house in winter. One

of the principal points to be considered in laying out your plans is to get the proper height, and the higher you build your house and the less floor space it occupies, the better will be your results. An 8x10 or an 8x12 foot house gives the best results. In this you could put an arch about nine or ten feet from the ground, and under the arch smoke your fresh sausage and above it smoke the meat. In this way the heat and smoke used for the sausage would also be utilized for smoking the bacon and hams and none would be wasted. If you build the way we have indicated be sure and put ventilators right above the arch so that cold air can be let into the smoke house during the real hot weather. If your fire gets too hot, you can feed cold air to the interior chamber, and if your smoke house is tall you can create a good draught and will soon get up a circulation which will cool the air so that the meat will not shrink too much. A smoke house built for simply two tiers of meat, that is, two rows, is better than one built wider. The walls of your smoke house can be built either of brick or wood, whichever you prefer, brick being the safer of the two. If you do not intend to smoke fresh sausage but only bacon and hams, it is unnecessary to put in an arch. In that case simply construct some iron bars about eight feet above the fire and on top of these put a heavy iron screen, so in case any hams should fall that they do not fall into the fire. Of course, you know that many smoke houses catch on fire and burn up, due to not having an iron screen above the fire and by meat falling directly into the fire.

PREVENTING PORK SAUSAGE FROM SOURING IN WARM WEATHER

QUESTION.—W. G. F. writes: "I make my own sausage, using your Bull-Meat-Brand Sausage Binder and your Sausage Seasoning. My sausage is good when it is fresh-made, but it soon becomes sour in warm weather. What can I do to prevent this trouble?

Answer.—The best and easiest way to overcome the difficulty you report about your fresh pork sausage souring in warm weather is to use our "A" Condimentine. In making your sausage, for each 100 pounds of meat add ¾ to 1 pound of Heller's "A" Condimentine. This will prevent fresh pork sausage from turning gray and souring for from eight to ten days, according to the temperature in which the sausage is kept.

"A" Condimentine will keep pork sausage in condition, so that it may be shipped, if necessary, for a considerable distance and still retain its own natural color. Your sausage maker will find this method of keeping fresh pork sausage from souring for a reasonable length of time in warm weather of great advantage and save you from severe losses. "A" Condimentine is legal to be used under the National and all State Pure Food Laws. The sausage does not have to be labeled to show the presence of "A" Condimentine. We will be pleased to have you try out our recommendation for retarding fresh pork sausage from souring and report to us your success at an early date.

ADVANTAGES OF STEAM-JACKET KETTLE IN RENDERING LARD.

Query.—C. W. F. asks: Is there any advantage in rendering lard in a steam-jacket kettle?

Ans.—There is. Both a caldron and a steam-jacket kettle work well. The best lard is made in one or the other. A steam tank in which the fat is put, and the steam turned right into it, will not produce as good lard as either the caldron or the steam-jacket kettle. The steam mixes right with the lard and the latter therefore contains a large amount of moisture and the lard does not keep well. Another disadvantage is that water used in the boiler is not always pure. If the boiler is not cleaned once a week the water will have a bad smell. Steam made from this water and turned into lard can not be expected to improve its flavor, even though it should not actually harm it. Those who kill large numbers of hogs usually have a steam tank for making steam rendered lard and a steam-jacket kettle for making their finer brands of kettle rendered lard.

SEASONING FOR SAUSAGES.

Query.—T. U.: Will you please send me a copy of your book, "Secrets of Meat Curing and Sausage Making." I have always used the following seasonings in my sausage: Pepper, summer savory and sage, and would like to know if you can recommend anything to me which will give the sausage a better flavor than these spices will. Any information you can give me in the seasoning of sausage will be very much appreciated.

Ans.—The Seasonings which you have been using are being used by a good many Sausage Makers, but a real fine flavored Sausage cannot be made with them. If you wish to increase your Sausage trade right along, and want to make Sausage that your trade will relish and enjoy, you must use the very finest Seasonings obtainable, as the Seasoning really is the life of the Sausage. We are manufacturing the Zanzibar Brand Sausage Seasonings, which we make for all kinds of Sausage. These Seasonings are made after secret formulas which have been in our family for a good many years. The flavor that these Seasonings impart to the Sausage is something very fine; it must be tasted to be appreciated, as we cannot describe in a letter what the flavor really is. It is a peculiar combination which everyone likes and it is something that will soon increase your Sausage trade. Zanzibar Brand Sausage Seasonings are manufactured from only high grade Spices and we guarantee them to be absolutely free from any adulteration. We are sending you our circular and price list and would be pleased to receive your order for any quantity that you may desire, and we will say in advance that when you once use them you will never again want to make Sausage without these Seasonings.

QUICKEST WAY TO CURE MEATS.

Query.—W. & B. write: Our capacity for curing meats is limited for the want of room. Can you give us a formula or a recipe that will give a good cure in the shortest possible time? We would like something that is reliable.

Ans.—Our Book, "Secrets of Meat Curing and Sausage Making," will give you all the information in reference to curing meats which you may desire. The curing period can be greatly shortened by pumping the meat. It will also give you a better article. Our book, which is mailed to anyone requesting it, free of charge, will give you full directions for pumping, and also the formula for making the pumping brine. By following the instructions which this book contains, you will be able to turn out the finest kind of mild cured and sweet pickled meats, which will have a delicious flavor and a fine color. It will be necessary, however, for you to fully carry out our directions in reference to chilling meats and overhauling them, also the temperature to be maintained during the curing period.

DIFFICULTIES WITH CURING BRINE AND HOW TO OVERCOME THEM.

Query.—W. S. & Co.: We are so situated that we have to boil all the water that we use in our brine. After boiling it we run it into a cooling tank and let it cool. We have made some experiments with your Freeze-Em Pickle and like it to cure very well, and have decided to adopt its use in the curing of all of our meats. Now, what we want to know is, can we dissolve the Freeze-Em Pickle in the boiling hot water and then cool it and run it through coils the same as we do now with the water? Would the heat affect the Freeze-Em Pickle? Our vats when full hold 6,900 lbs. of medium sized hams. According to the size of the kettle and the amount of water to boil at one time, it would require 18 pounds of Freeze-Em Pickle. What we want to do is this: we do not want to weigh the Freeze-Em Pickle for each vat, but simply want to make a large quantity of brine and then run the prepared brine on to our hams. We have been using saltpeter and molasses for our brine and we are having trouble with it getting ropy and stringy. Will syrup answer the same as molasses or sugar, and is New Orleans molasses the best, or should granulated sugar be used entirely? Kindly let us know what you consider the best for hams.

Ans.—First of all, we advise that after the water is boiled, that it is allowed to settle and precipitate so that all the solids will settle to the bottom of the settling tank. It should settle at least 24 hours before the solids will have separated and gone to the bottom. Then the water should be drawn off, but not from the bottom of the tank, but at least a foot from the bottom. The water that will come off from above will be nice and clear. This water should then be run into another tank, called the mixing tank, in which the sugar, salt and **Freeze-Em-Pickle** should be dissolved; this will make the stock brine which can be run down into the cellar over cooling pipes, so as to chill it properly before it is put on the meat. The reason the brine that you are making becomes ropy is that you are using the wrong sugar. If you will use absolutely pure granulated sugar or absolutely pure syrup made from granulated sugar you will have no trouble from ropy brine. We strongly advise the use of nothing but absolutely pure granulated sugar. We find that it gives the best results. It costs a little more than the unrefined product but you get less vegetable substance in your brine, and the brine will therefore keep much longer. The brine in which hams have been cured can be used a second time for curing breakfast bacon, and the breakfast bacon will be even better than if put into fresh brine. As your vats are large, the meat will pack very tight on the bottom, and we wish to caution you to be sure and overhaul your meat promptly five days after it is packed and continue overhauling as per directions in our book on curing meats and making sausage. If you follow these directions you will not have any ropy brine or any spoiled meat, but all your meat will come out uniform and will have the proper flavor.

TOUGH AND SALTY CORNED BEEF.

Query.—E. W. G. writes: I have had complaints from several large institutions I serve that my corned beef is tough and too salty. I would like to know about what proportions of salt and saltpetre to use. It is only recently that I have had these complaints, in fact, I have been in the retail business for about ten years and have been very successful with my corned beef.

Ans.—If you will use the following in curing plates, rumps, briskets, etc., for corned beef, you will have no trouble. Use for 100 lbs. of meat:

Five pounds of common salt, 1 lb. of **Freeze-Em-Pickle**, 2 lbs. of best granulated sugar, 5 gallons of cold water.

Cure the meat in this brine fifteen to thirty days, according to weight and thickness of the pieces. If you are taking pieces out of the brine from day to day and adding others, you should keep up the strength of the pickle to sixty degrees by adding a small quantity of **Freeze-Em-Pickle** and salt from time to time as you withdraw and replace the meat. One of the first essentials to producing first-class corned beef is to be careful about the temperature during the curing period. An even temperature of 38 degrees Fahrenheit is always the best for coolers and for curing meat. If maintained at this degree, there will be no trouble from taking on too much salt, provided, of course, the meat has been properly chilled through before placing it in the brine for curing. In order to produce a good cure, all the animal heat must be extracted from the meat before it is packed, otherwise it will become soft and spongy in the brine, and pickle-soaked.

KEEPING HAMS AND BACON SIX MONTHS.

Query.—A. J. M. writes: I would like to know how to keep hams and bacon in first class shape for the next six months without their getting mouldy and with the least possible shrinkage.

Ans.—There is no practical method for keeping hams and bacon for so long a time after they are smoked without their getting mouldy. There is a method for keeping them in sweet pickle for any length of time, provided you have cold storage facilities. All kinds of pickled meat if stored in a cooler in which the temperature is kept down to 28 degrees can be kept in this cooler for a year or even longer, and when removed will come out like fresh cured meat. Hams and other meats are often purchased when the market is low and stored in a freezer and kept here until such a time that they are in greatest demand and will sell at the highest price. At a temperature of 28 degrees the meat

will not freeze after it is cured, and the brine, of course, does not freeze at that temperature. When meat is taken out of such cold storage to be smoked, it should be first soaked from three to five hours in fresh water, and then washed and smoked the same as regular fresh cured meat. Farmers often bury their smoked meats in their oat bins, and are enabled to keep them in good condition for some time, but this is a method which, perhaps, does not suit your purpose. It is best to keep the meat in sweet pickle until you are ready to smoke it, as this will insure a much better article.

USES FOR DRIED BEEF ENDS.

Query.—C. E. C. writes: "Can you inform me the best and most profitable way for disposing of my Dried Beef ends? I am in the sliced Dried Beef business and have no way of using up my ends. Thanking you in advance."

Ans.—There are three ways for disposing of beef ends to advantage and profit. They may be ground up in an Enterprise Chopper and sold to hotels and restaurants for use as Minced Dried Beef to be prepared and served in cream. They can also be sold to concerns engaged in the baked bean business, where the ends can be cut up and baked with pork in the beans. Restaurants can also use dried beef ends to excellent advantage by putting them in soup. They will give a delicious flavor to all kinds of soups, if boiled at the same time with other soup meats.

HOW TO PREVENT HAMS FROM SOURING IN THE HOCK.

Query.—C. F. G. Co. write: "We have a lot of hams that we put down in dry salt to cure about six or seven weeks ago, and we have discovered that they have become tainted in the hock, while the balance of the piece of meat is all right. Can you tell us any way to rehandle or overhaul these hams to save them? The front or butt end of the ham is sound and all right and sweet; the bad part is in and around the hock end or leg end. Could this taint and odor be removed and the meat made sweet by putting these hams down now in a strong salt brine and punching holes in the hock end of the pieces so that the brine could quickly get into the tainted part? Would salt brine save them now? We will thank you for any advice or plan of action that will help to save us from loss."

Ans.—It is more difficult to cure hams by the dry salt process than it is by the brine process. If these hams had been pumped before packing them in the salt, there would not have been so much danger of shank sour. Hams being very thick, it takes a long time for the salt to draw through them; therefore, if they are first pumped and packed in dry salt, you can readily see that the salt draws through quicker and thus gives them a chance to cure from the inside as quickly as they would cure from the outside. Only under one condition can you pump these hams, make them sweet and save them. For instance, if the hams are taken from the salt and upon trying them with a ham trier they are found to be sweet but turn sour when they are placed in the smoke house, then you can save them. Such a condition would show that the hams are not fully cured around the bone and around the shank joints. In that event, they can be pumped with pickle and fully cured around the bone so that they will not sour when placed in the smoke house. It is necessary to explain that meat is frequently perfectly sweet when it comes out of cure, but it is not fully cured. In such a condition when it is placed in a warm smoke house, it will sour in the smoke house. This, of course, can be avoided by fully curing the hams. If, on the other hand, the hams are already sour and tainted when they come out of the cure, whether it be dry salt or sweet pickle, then nothing can be done with them to make them sweet. Meat once spoiled, remains spoiled. If the hams are sour when they come out of the cure, but sour only in the shank, then the proper thing to do is to cut off the shank; in other words, cut off all the sour or tainted meat and use the butt ends for boiled hams. You can boil and slice them and sell them in your store. You must be careful to cut off all the tainted parts because any of the tainted meat which is left will taint all the rest of the meat when the butt is boiled. You, of course, understand that during the process of boiling, the good meat will absorb the taint from the bad meat. We regret that you did not write us for advice before you began curing the hams, as we would have advised you to cure in brine. We will send you by mail, free of charge, our book, entitled "Secrets of Meat Curing and Sausage Making," which covers every point that its title indicates. The advice given in this book as to the handling of meats, you will find very valuable and covers the whole ground, from the condition of the animal before killing to the handling of the meat through the chill room and through the entire curing process. We call your special attention to the various articles for curing meats, which will give you the temperature for curing, how to overhaul the meat, how to pump the meat and how to make the brine for pumping. Full directions for curing the hams you will find carefully indexed. By following the advice given in these pages, you will have no loss from the souring of meats, but on the contrary, will be enabled to turn out meat of the highest quality possible.

BUILDING A COOLER.

Query.—W. G. H. writes: I have about completed a cooler except the floor and am undecided whether to make it of plank or cement. I thought you could give me the desired advice. One room is 16 feet square inside; 7 feet to joist with 7 feet of solid ice above, or about 50 tons capacity. The walls are 2 feet thick; 8 inches sawdust, 4 inches dead air space, 8 inches sawdust, with four thicknesses of one-inch boards, thus making the 2 feet. The building has these walls on all sides and partitions. I expect to use the drip from the above to cool another room, 8 feet by 16 feet inside, and will have the water run around this room in gutters (sheet iron) fastened to the wall. I want this as dry and as free from mould and dampness as possible and, therefore, am not sure as to whether a cement floor will be what is needed, though it was my intention to use cement. There is a 2-foot stone wall under the cooler which sets on sand—this sand having been washed up at times past by the lake. There are now fifty tons of ice over the cooler and back of this is an ice house, 16 feet square, inside filled with ice 14 feet high. This makes the building 20 feet wide by 48 feet long, by 20 feet studding. For ventilation a four-inch square flue will run from the bottom in one corner and from the top in the opposite corner of the cooler to the top of the roof, and above it, acting as chimneys. I want to use these coolers for fresh meats, packing hams and bacon, storing eggs and most anything that there is any money in, which requires to be kept in good condition. Your advice will be appreciated.

Ans.—You are building your cooler on very good plans. However, we would advise the use of cement for the floors. It will be found much better than wood, much purer and cleaner, and withal much drier. You speak about putting two ventilators in your cooler, which is all right, but you should be sure to provide these ventilators with slides, so you can shut

them off and regulate the ventilation according to your wishes. Of course, you understand that it is not well to have the ventilators open all the time, as it would result in quite a loss of ice. The ventilators should be open only when the room needs ventilation, which will be at well-defined periods, or varying according to the amount of material in storage. Your plan of using the drip water of the ice and running it in pans will work all right. We have seen this method applied, and it was always satisfactory. Be sure to use galvanized iron gutters for the pans, not sheet iron, as it will rust easily.

WHY BOLOGNA "TAKES WATER" IN COOKING.

Query.—H. P. writes: "Sometimes I have bother with my bologna taking water when cooking them. Can you tell me what to do to prevent this trouble?"

Ans.—The difficulty you mention is caused by the sausage not being properly boiled. Ordinary round or long Bologna should be boiled in water of 160 to 170 degrees Fahrenheit for about thirty to forty minutes, and thick, large Bologna should be boiled in water of 155 to 160 degrees for from three-quarters to one hour, according to the size. If the sausages are very large, it will take from one and one-quarter to one and one-half hours to cook them properly. After sausage of any kind have been cooked, they should be handled as follows: Pour boiling water over them to wash off all the surplus grease that adheres to the casings, and then pour cold water over them to shrink and close the pores of the casings. This is very important and should be closely observed by all packers and sausage makers who wish to have their sausage look nice and keep their fresh appearance. The shrinkage and quality of cooked Bologna depends considerably upon the temperature in which they have been boiled. It is very necessary for every man who cooks sausage to use a thermometer.

WHY BOLOGNA SHRIVELS.

Query.—T. B.: Can you tell me the reason bologna shrivels when it is taken from the hot water? It looks fine until it gets cold.

Ans.—There are several reasons why your bologna might shrivel when taken out of the boiling water. First, it might be that you do not cure your meat right before the bologna is made, and second, you probably do not use the right kind of a binder, and third, you probably boil the bologna in too hot water. If when the meat is cured properly and you do use the right kind of a binder, the bologna shrivels when taken out of the boiling water, it is because you are boiling it at too high a temperature. Before making bologna you should sprinkle Freeze-Em-Pickle over the meat and leave it for a few days. We refer to our instructions for preparing bologna trimmings, which will be found in our book, "Secrets of Meat Curing and Sausage Making."

ADVICE ON CURING HAMS AND BACON.

Query.—E. A. S. & Co. write: I have taken a barrel of meat, hams and shoulders, which I cured in my ice box after your instructions, and I wish to say that it is as fine as was ever produced by anyone. My ice box holds well, standing at from 38 to 39 degrees, but it is small and only has room for one barrel in it. I have made arrangements to try packing in the house this winter. I have a closet made of brick on both sides and by proper ventilation in cold weather so as to keep it from 35 to 40 degrees. I think I can save hams all O. K. in tierces. I have about ten oak tierces for the purpose. (Is that all right?) I have an old ice box in the rear 8x8 feet with a good roof on it, walls filled with sawdust. I would like to know if I can fill this with hams and shoulders when the weather gets cold and just dry salt them. Can I save them by just letting them stay there all winter until next spring? I can put in a layer of hams and cover them with salt, then put in another layer and cover with salt, and so on until I fill it. I would like your opinion and advice as to these methods. I kept side meat this way last winter just leaving it in salt.

Ans.—If you keep the temperature of the small room which you mention at from 35 to 40 degrees it will answer the purpose for curing. The oak tierces for curing are all right provided they are new. We advise that you wash them out with scalding hot water, so as to get rid of the oak taste. If the tierces are not new, then you must make doubly sure that they are scalded out thoroughly and at the same time you should use our Ozo for cleansing them.

The old ice-box which you mention can be used for dry salting hams and shoulders when the weather gets cold, provided you do not let the meat freeze. You must not let the temperature get below 35 degrees, because at a lower temperature, meat will not take on salt. Hams can be dry salt cured just the same as side meats, but when hams are very thick, we would advise that you pump them. Our book, "Secrets of Meat Curing and Sausage Making," will give you full information as to the pumping process and a formula for making the pumping brine. Hams are very seldom dry salt cured; they are nearly always sweet-pickle cured. A sweet pickle or sugar cured ham has a much finer flavor than the dry salt cured ham.

If you pack side meat properly and overhaul it regularly until it is fully cured, and if you keep the temperature of the curing room at about 38 degrees, you will have no trouble in keeping dry salt meat in salt all winter. Of course if you keep it in salt too long, it will get very salty. Our book on curing meats will give you full directions for dry salt curing. Hams, after they are fully cured in brine, can be rubbed with salt and kept in a cooler for several months, and if desired, all winter, but the shrinkage will be great and they will take on salt and might become too salty for your trade.

WHY OIL SEPARATES FROM LARD.

Query.—E. & W.: We are having trouble with our lard; the oil separates from the lard during the warm weather so part of the lard is really oil, and we cannot use it in that condition. Our business is too small to justify us in employing a practical man to take charge of our lard. We ask you for your advice.

Ans.—To keep the oil from separating from the lard, you should carry out the following directions: First, you should provide yourself with a lard cooler with an agitator attached, as the lard after it is rendered and when it begins to cool should be agitated until it becomes thick like cream, before it is run into the buckets. If lard is not agitated, when it is cooled the stearin crystallizes and the oil separates from the stearin, but by chilling the lard and by agitating it while it cools, the stearin does not get a chance to crystallize and the oil will not separate and the lard will keep better in this condition. Lard that is put up in winter for summer use is much improved by adding about ten per cent of tallow, but when this lard is sold, it should be sold as lard with ten per cent of tallow added. If you wish to treat the lard that you have on hand, we advise you to treat it as fol-

lows: For every 100 lbs. of lard, put 100 lbs. of water in your lard kettle; add to it four ounces of our Lard Purifier, and throw 100 lbs. of lard into this water. Start the fire and gradually heat it until the lard is melted and is as hot as it will stand without boiling over. Keep on stirring the lard until it begins to melt, so as to thoroughly wash it. After the lard is thoroughly washed, you will find a certain amount of scum will come to the top, skim this off and then allow the lard to settle for about two hours, so that all the water will separate from the lard and settle down at the bottom. Skim the lard off the top of the water and then let it cool, but keep on agitating it or stirring it while it is cooling, until it is thick like cream.

COATING BOLOGNA SAUSAGE NOT NECESSARY TO PREVENT MOULD.

Query.—E. D. writes: I would like to ask you if you have anything to coat bologna with after making? I think it is called Gloss or Lustre; have seen it used, but have not been able to find out where to get it.

Ans.—What you refer to is Bologna Varnish. The use of such a preparation has been practically discontinued as it does not conform to pure food laws; it is not proper that a varnish should be put on the outside of food of any kind. Bologna Varnish is made from shellac, and shellac is used in all kinds of furniture varnish, so you can readily see that it is not the proper thing to use on Bologna. In former years, the use of varnish was quite general, but it was finally discontinued, and is now practically a thing of the past. If you want to prevent your Bologna from getting mouldy, you should make them as follows: First, cure the meat with Freeze-Em-Pickle as directed in our book, "Secrets of Meat Curing and Sausage Making," and add Bull-Meat-Brand Sausage Binder to the meat, as this absorbs the moisture. Bologna made by the Freeze-Em-Pickle Process keeps fine and will not mold for a reasonable length of time.

MAKING SOAP FROM TALLOW.

Query.—F. B. writes: We have a little meat business and quite often have on hand a surplus of tallow. Now we have been thinking probably we could put this into a soap, something cheap that would not cost us too much to put on the market. Can you kindly give us any information in the matter, and if the idea is a practical one for a small shop like ours?

Ans.—It would not pay you to undertake to make a hard soap in a small way, as it would be necessary for you to compete with other soaps on the market, and you are aware that laundry soap sells at a very low price and is put upon the market upon a very small margin of profit. You would also find it quite a task to make hard soap, and the time required would hardly justify you to undertake it on a small scale. If you can dispose of soft soap in your locality, we would advise you to use your surplus tallow in that way, but, of course, this suggestion from a financial point of view would depend entirely upon whether there is a sufficient demand for such an article in your vicinity. Possibly you could work up a trade among private families and sell it to them for scrubbing purposes, also to hotels, stores and restaurants, but as your town is small, you might have difficulty in disposing of a sufficient quantity to make it pay you. On the other hand, it would not cost you much to make the experiment. You are surrounded by a good hog-feeding country, and it is possible that you could dispose of quite a quantity of soft soap to the farmers, as it is a very fine thing for hogs, and the truth of the matter is, their hogs would be much better off if they would feed it frequently. You might be benefited more by this suggestion than by sales from other sources.

The following is a recipe for making soft soap with potash: To 20 pounds of clear grease or tallow take 17 pounds of pure white potash. Buy the potash in as fine lumps as it can be procured, and place it in the bottom of the soap barrel, which must be water-tight and strongly hooped. Boil the grease and pour it boiling hot upon the potash; then add two large pailfuls of boiling hot water; dissolve 1 pound of borax in 2 quarts of boiling hot water and stir all together thoroughly. Next morning add 2 pails of cold water and stir for half an hour; continue this process until a barrel containing thirty-six gallons is filled up. In a week or even less, it will be ready for use. The borax can be turned into grease while boiling, and also 1 pound of rosin. Soap made in this manner always comes, and is a first-rate article, and will last twice as long as that bought at a soap factory. The grease must be tried out, free from scraps, ham rinds, bones, or any other debris; then the soap will be as thick as jelly, and almost as clear. To make soft soap hard put into a kettle four pailfuls of soft soap, and stir in it by degrees about one quart of common salt. Boil until all the water is separated from the curd, remove the fire from the kettle and draw off the water with a siphon (a yard or so of rubber hose will answer); then pour the soap into a wooden form in which muslin has been placed. For this purpose a wooden box, sufficiently large and tight, may be employed. When the soap is firm turn out to dry, cut into bars with a brass wire and let it harden. A little powdered rosin will assist the soap to harden and give it a yellow color. If the soft soap is very thin, more salt should be added.

PLANS FOR SAUSAGE FACTORY.

Query.—O. C. L. writes: I am now in business again on my own hook, so please send me your book on Meat Curing and Sausage Making. I will, in the near future, equip my market with an up-to-date sausage factory. I have the following machinery: 1 six-horse power gasoline engine, silent cutter, Enterprise machine, 1 bone cutter, 1 steam boiler for rendering lard, cooking sausage, etc. The room I intend to place this machinery in is 15x25 feet; would like to hear some of your suggestions, and plans in placing the machinery; would appreciate this very much. Has the freezing of pork sausage any detrimental effect on the flavor of the sausage? Accept my well wishes.

Ans.—The machinery you enumerate will give you a sausage plant that is quite complete. We think, however, that your room is a little bit small in which to place so much machinery. If you could put the boiler and rendering kettle in another room, away from the sausage factory, it would be better. You would probably be able to make such an addition as would answer your purpose at a very small cost. This arrangement would make it much more convenient because the boiler and the rendering tank in your sausage factory will make it very hot. The arrangement or disposal of the machinery will not make material difference in a room of the size mentioned. You can arrange it most any way to best suit your convenience.

The freezing of pork sausage certainly has a most

detrimental effect on the flavor. Freezing meat always tends, to some extent, to spoil the flavor of the meat. When the albumen of the meat is frozen, and is afterwards thawed out, the albumen leaves the cells of the meat and in that way the flavor is lost and the meat becomes insipid.

PURIFYING TALLOW.

Query.—T. W. C. writes: "I am tanking mutton and beef tallow together at 40 pounds pressure, and would like to know the best way to use your tallow purifier so I can use my tallow with cottonseed oil to make a lard compound."

Ans.—It would not be practicable to use our Lard and Tallow Purifier in the tank. It can be used to greatest advantage in an open jacket kettle. You can treat the tallow in the jacket kettle after it is rendered and comes from the steam tank.

HOW PACKERS BRAND THEIR HAMS

Question.—W. Z. writes: How do packers brand their hams.

Answer.—Packers brand their hams with ink made from the following formula:

Glucose	2¼ lbs.
Lampblack	¼ to ½ lb.
Water	1½ lbs.
Grain Alcohol	½ pint

Place the Glucose and water in a dish and heat on stove until it becomes thin. Now take the Lampblack, put it in a separate dish and add enough of the water and Glucose so as to make a thick paste; work this paste up until all of the lumps are dissolved. Then take the Lampblack paste and gradually mix it into the water and Glucose until the desired shade of color is secured. After mixing thoroughly remove from fire and set aside to cool. When cool add the ½ pint of Grain Alcohol, mixing thoroughly. Keep in a corked bottle or can.

Spread a small quantity of the Ink thus made over a pad which is easily made by taking 10 thicknesses of cheese cloth and tacking them on top of a flat board. The branding itself is done with an iron brand containing such letters or other marking as you wish to appear on the hams. The branding should be done before the hams are put into the smoke house.

STARTING A BUTCHER BUSINESS

Query.—M. E. A. writes: Will you please forward me another copy of your desirable book, "How to Cure Meat and Make Sausage"? And if it is not too much trouble, I would like to have you advise how it is best to start in the butcher and pork packing business in a small way. I have about $700 capital and wish to ask how is the best way to fit up a retail store without too much expense and yet to have it look good, and also to fit up a sausage kitchen and have everything that a man needs to run the business successfully. I may as well state that I have had lots of experience, but after reading your book and the advice that it gives I am sure that even experienced men can learn a lot by reading it.

Ans.—With such a limited amount of capital, it would be advisable to buy second-handed fixtures. These can always be obtained much cheaper than new ones, and you can get good fixtures which will answer the purpose, but they must be neat, clean and in good repair. If you intend to do your own butchering, our advice is that you make arrangements with some butcher who has a slaughter house, and where you can do your butchering, and pay him a certain amount for each animal slaughtered. A very important point that we advise you to follow is to sell everything for cash only, as your capital is not sufficient to give credit to anyone. Were you to give credit and make a lot of book accounts, you would soon run out of money and would not be able to buy large stock and supplies for your market. We also advise that you induce your customers to take their meat home with them, and thus relieve yourself of the necessity of keeping a horse and wagon for delivery purposes. This would save quite an outlay in capital, and a great deal of expense and time. You can then announce with a small advertisement in the daily paper that you sell for cash only, and that you can afford to be more liberal with your customers than you could if you carried accounts, and because you do not incur the expense of delivery. Such an advertisement with placards in your store, no doubt, would result favorably. You must remember at all times that your capital is limited and that you must "trim your sails" accordingly. It is the over-reaching the limits of the possibilities of capital that make the most failures among tradesmen. We would not advise you to advertise meat at a cut price because you sell for cash; people do not want stuff that is cheap, for if you sell stuff at a low price, they imagine there is something wrong with it. Charge the same price that all the other butchers do, and in that way, keep their friendship. If a woman gets something that she doesn't like and brings it back, tell her that you are very glad she brought it back, if it did not suit her, because you never want any of your customers to keep anything that does not please them.

A sausage room can be rigged up very cheap; all you need to start with is a small Enterprise grinder, so that you can grind up your trimmings and work them into sausage, and by working the meat trimmings up into the different formulas that we give in our book, "Secrets of Meat Curing and Sausage Making," you will not have any loss, as all of your trimmings can be worked up to good advantage. You also should make a great display of your own cured corned beef and turn out fine corned beef, so that when your customers buy it, they are well pleased. The main thing in the success of running a retail market is that the butcher understands how to buy his live stock so that he gets the right quality of beef and gets it at the right price. If you have good meats to sell you will have no trouble in selling them, but if you have poor goods to sell, you may sell them to a customer once or twice, but the third time the customer will not come near you. The same thing holds good with you; if you were buying some of your supplies from the jobber and the jobber did not send you good goods, you may try him once more and if he again sends you poor goods, the third time you certainly will not buy from him, but you will go to some other jobber who will give you the best goods for your money. Your customers are just as smart and as sensitive as you are, and want the same kind of treatment that you like, so if you will always treat your customers as you would like to be treated yourself if you were buying meat at a market, you are bound to meet with success.

CUTTING UP MEATS—NECESSARY FOR EXPERIENCE.

Query.—J. J. writes: I have decided to go into the meat business and would like to know if you can advise me of some booklet or pamphlet on cutting up meat; also let me know the price of your book, and if you know of

a good firm handling butcher supplies and refrigerators.

Ans.—We judge from your inquiry that you are inexperienced in the meat business, and if such is the case, we would advise that you go to work for some good butcher for a while before going into the business for yourself. You could there learn the practical side of the business, and provided you do not now understand how to cut up meat to the greatest profit, you could acquire knowledge upon these points which would be of more value to you than volumes that could be written upon the subject. We most emphatically advise you to learn the business thoroughly before embarking into it on your own account. We take great pleasure in sending you our booklet, "Secrets of Meat Curing and Sausage Making," which you will find of great value to you in teaching you to cure meat and make sausage.

SOURING OF HAM IN SMOKE HOUSE.

Query.—M. P. M. writes: "I am having trouble with my hams souring in the smokehouse. They seem to get too much smoke. What can you suggest that will help me to avoid this trouble and to keep my hams sweet?"

Ans.—You are mistaken in supposing that your hams sour from getting too much smoke; that is not the trouble. Hams will not sour from such cause. Your trouble is owing entirely to the fact that the hams are not properly and fully cured before going into the smoke house. Smoke aids to preserve hams and will not cause them to sour. They sour because the portion that has not been thoroughly cured, which is generally close to the bone, has not been reached by the brine. In many cases souring comes from imperfect chilling of meat before putting it into the brine; then again you may not have overhauled the meat at the proper time and with the frequency which good curing requires. In the first place, the hog should not be killed when overheated or excited. Second, after they have been scalded and scraped, they must be dressed as quickly as possible, washed out thoroughly with clean water, then split and allowed to hang in a well ventilated room until partly cooled off. They should then be run into a cooler or chilling room as quickly as possible, where the temperature should be reduced to 32 to 34 degrees Fahrenheit. They should be allowed to thus chill for 24 hours for medium size hogs. When hogs are properly chilled, the temperature of the inside of the ham or shoulder will not be more than one to one and one-half degrees higher than the cooler. Those without ice machinery for curing, who are using common ice houses, can employ the crushed ice method for chilling the meat. By this is meant to put the meat on the floor and throw cracked ice over it, and thus allow it to remain over night. After being thoroughly chilled, the hams must undergo the various processes which you will find set forth in our book, "Secrets of Meat Curing and Sausage Making," which we take pleasure in sending to you free of charge. If you will follow the directions contained in this book you will never have trouble with soured hams from imperfect curing or other causes.

CLEANING CASINGS.

Query.—S. & H. write: "I would like to know if you have any preparations for cleaning casings. We clean all the casings we get and would like to get some chemicals to take the tallow and lard off of them."

Ans.—There is no preparation that will free the lard from casings. If you use something that is strong enough to take off the fat, it will eat up the casings as well. The only thing practicable that can be done is to wash the casings thoroughly and change the water a number of times. In the last washing water it would be advisable to put in some washing soda as that will soften the water and assist in cleaning the casings. The fat you will have to remove by hand. There are machines made for removing the fat from casings, but it will not pay you to go to the expense of making such a purchase unless you clean a very large amount of casings per day.

CAUSE OF "RUSTY" MEAT.

Query.—R. J. B. writes: "We keep our meat in an ice box 35 degrees cold and the barrels we used in curing it were galvanized, and we have used them for five years. We use the regular pickling salt. Our meat comes out rusty. What can you suggest?"

Ans.—If your cooler is kept at 35 degrees, you must have an ice machine instead of the regular ice box or cooler, and 35 degrees is too cold for curing purposes. An even temperature of 38 degrees is the proper one for curing meat, and all packers who use ice machines should endeavor to keep their coolers at a temperature not varying from 37 to 39 degrees, and they never should be allowed to get above 40 degrees. Meat will not cure in any brine or take on enough salt when dry salted if stored in a room that is below 36 degrees. If meat is packed even in the strongest kind of brine and put into a cooler which is kept at 32 to 33 degrees and thus left at this degree of cold for three months, it will come out of the brine only partly cured; it will, therefore, only keep for a short time and will start to decompose when taken into a higher temperature. If you have used galvanized iron tanks for five years, it is possible that the zinc or the galvanizing is worn off on the inside of the vats so as to expose the iron. Brine will rapidly rust iron and that will cause your meat to become rusty. Galvanized iron tanks for curing are all right until the galvanizing is worn off and the moment this happens, the tanks are useless for curing purposes. Salt that is rusted or salt that is shoveled with a rusty shovel will also cause rusty meat. It is absolutely necessary that the salt be pure and free from rust. If live stock is driven for some distance and slaughtered while it is overheated, the meat will not cure properly and will also turn out rusty. Stock that has been driven should always be allowed to remain in the pens over night. We send you our book, "Secrets of Meat Curing and Sausage Making," which you will find full of valuable information in reference to curing of meat. If you will follow the directions contained therein closely, you will always have good results.

SALT FOR BRINE—BOILING BRINE—ROPY BRINE.

Query.—W. M. writes: "Is common barrel salt or rock salt the best and cheapest to use for making brine? I have been using rock salt and I think it is sweet, but in using rock salt I have to boil it in order to dissolve the salt. Is it necessary to boil the water if it is pure? I am

having trouble with my brine. It becomes jelly-like in summer and in winter. What is the cause of this?"

Ans.—Evaporated salt, or what is known as the ordinary barrel salt of a good quality, is generally approved by butchers for making brine. Rock salt is much used by the large packers, as it is a stronger salt, but their facilities for curing meat are altogether different from those of the butcher and the ordinary curer.

It is not necessary to boil the water for brine if you know it to be perfectly pure. If its purity is doubted, it should always be boiled and the impurities which rise to the top should be thoroughly skimmed off, or if they precipitate the water should be carefully drawn off. When brine becomes jelly-like, you mean that it gets ropy. This condition is owing to a great many causes; sometimes it is due to the sugar which may be of low grade or unrefined, or where molasses and syrup are used, it quite often results. The best grade of granulated sugar should always be used for brine. Sometimes the ropiness of brine is due to the packages in which the meat is cured. This is especially true when syrup barrels are used. One of the most common causes of ropy brine is owing to the fact that the meat is cured in too warm a temperature. If the curing temperature is kept from 38 to 40 degrees, the brine will remain thin and not get ropy, but there is always risk in a temperature higher than we have given. If the meat has not been properly chilled before putting it in pickle, ropiness will also result. Great care should always be given to meat before putting it in the brine, as it will become soft and spongy if not chilled through to the bone. When in this condition it becomes pickle-soaked and contaminates the brine.

PACKING EGGS.

Query.—D. B. writes: "I have been using your goods for some time back and they give the best of satisfaction. Can you give me a good recipe for packing eggs?"

Ans.—You will find the following very efficient for preserving eggs: To each pailful of water add two pints of fresh slaked lime, one pint of salt and one ounce of White Berliner Konservirungs-Salze; mix well and then fill a barrel half full of this fluid, put the eggs into it and they will keep for a long time. The eggs, of course, should be stored in a cool room. A cool cellar will answer, but the temperature should never be allowed to get too low—never lower than 38 degrees.

HOW TO TEST VINEGAR.

Query.—G. G. writes: "Do you sell a thermometer or gauge for testing vinegar? How am I to know the degree of strength of the vinegar without a gauge?"

Ans.—Vinegar is tested with a special apparatus called a Twitchel Tester. Unless you use large quantities of vinegar, it would hardly pay you to go to the expense of buying such an apparatus as they are rather expensive and cost about $15 each. If you buy the vinegar by the barrel from the wholesale grocers and specify the degree of strength, they will give you the article desired. If you have any doubts as to the purity of vinegar there are various ways to test its purity. The adulterant of vinegar is sulphuric acid, which increases its indicated strength. Sulphuric acid can be detected by placing some of the vinegar to be tested in a saucer. Put some white sugar in the vinegar and evaporate to dryness by placing the saucer on top of a boiling water kettle. After the water has evaporated if the sugar turns black, the vinegar contains an adulterating acid. In lieu of a saucer, a teacup can be used in which the vinegar and sugar can be placed. The cup can then be placed in a basin of hot water in which it can be allowed to float until the vinegar in the cup is evaporated. If the vinegar contains free sulphuric acid the dry sugar will be found to be blackened. These are simple methods and are claimed to be more accurate as a test than the use of the Barium Chloride Test. The Barium Chloride Test is as follows: Mix one ounce of Chloride of Barium with ten ounces of water. A little of this mixture dropped in vinegar will quickly test its purity. If the vinegar contains sulphuric acid, this mixture will make it turn flaky at once, but if it remains clear and shows no change, the vinegar is free from sulphuric acid adulteration. Sulphuric acid makes vinegar show a very high test when, as a matter of fact, it is of very poor real vinegar strength.

SEPARATING WATER FROM LARD.

Query.—C. W. writes: "I have my lard in such a shape that I don't know what to do with it. It seems that the water will not separate from the lard and the mixture stays about the thickness of cream and about as white. Can you give me any instructions or advice?

Ans.—To overcome your difficulty, we would advise you to remelt the lard and heat it quite hot, even up to 190 to 200 degrees, but do not let it come to a boil. Then let the lard settle. The water and impurities will settle to the bottom. The lard will rise to the top. If you heat the lard to the boiling point of water, that is, 212 degrees, it would do no harm except that the lard will then foam and you will have to be careful so that it does not foam over the top of the kettle. When it foams, it will bring the impurities to the surface, besides much of the moisture will evaporate. Either of these methods will remove your difficulty. You can dry the lard by heating it sufficiently or you can melt the lard and have it hot enough so that the water will settle to the bottom. After the lard is melted, dip it from the kettle, or if you have a lard cooler, run it into the lard cooler; be careful, though, that all water which may be at the bottom of the kettle is drawn off first if your intend to run the lard into a lard cooler. You will have to get rid of the water that is in the lard, so do not stir the lard while the water is still in the kettle. If you dip the lard out of the top of the kettle and place it in a lard tierce, when the lard begins to cool, you can stir it and keep on stirring it until it is thick like cream; it should then be run into buckets. You can readily understand that if there is a large per cent of water in the lard, it will keep the lard soft, which is the trouble you are now having.

WHITENING AND PURIFYING TALLOW.

Query.—Messrs. S. B. write: "We render our tallow and other slaughter house offal all together in the regular tanks, and we would like to inquire whether you have anything that will whiten it after it is rendered."

Ans.—You can treat the tallow and whiten and

purify it after you have rendered it in the regular manner in your tank if you are willing to go to the additional labor of treating it in your open jacket kettle. The proper way to do is to fill your open jacket kettle or caldron, whichever you may use, about one-third full of hot water; dissolve in this a one-pound package of our Lard and Tallow Purifier, then on top of this put the tallow after you have rendered it. It will make no difference whether the tallow is hot or whether it is cold. Get the water boiling hot; stir the water and the tallow frequently, about two minutes each time. This stirring should be at intervals of about five minutes for from fifteen to twenty minutes; then turn off the heat and permit the tallow to settle; next skim off the tallow from the top. More tallow can be treated in the same solution in the same manner; in fact, you can use the same solution in the jacket kettle two or three times. It should then be renewed with a fresh solution because the water will become impure, as the impurities of the tallow remain in the water and contaminate it; while in this condition the Tallow and Lard Purifier will exhaust its strength. Of course, more Lard and Tallow Purifier could be added to the same solution, but it is advisable to change the water occasionally as it will aid materially in purifying the tallow.

MEAT MOULDING IN A COOLER.

Query.—M. & S. Co.: Please forward to us one of your brine tester hydrometers. Ought fresh beef to mould in a cooler where the temperature is 36 degrees, after being in there ten to fourteen days? We have lost meat this way in a cooler with three coats of white lead throughout and the temperature maintained by ice. Not only has meat moulded, but it has had a pine taste.

Ans.—As requested, we have sent you a hydrometer by express. You wish to know if fresh beef stored in a cooler ten or twelve days should begin to become mouldy. You say that your cooler is cooled by ice and that its temperature is 36 degrees. We are inclined to believe that your thermometer is not accurate. It would be very difficult to get the temperature of a cooler down to 36 degrees with ice. If an ice box is kept closed from Saturday night until Monday morning the temperature runs down to 36 or 37 degrees, but where it is in constant use, and opened from time to time throughout the day it is almost impossible to reduce the temperature to 36 degrees, unless the cooler is a very small one and a large amount of ice is packed in the ice chamber above. Try another thermometer. It is important to have one that is right. Do not buy a cheap thermometer for a cold storage tester. If your cooler is constructed properly it should be perfectly dry and all the drip water drained without entering the storage chambers. A cooler, even when cooled with ice, should be so dry on the inside that a match might be struck on the sides. If the cooler is moist, there is no need to search further for the cause of your meat moulding. If the cooler is perfectly dry then the beef will keep about two weeks without moulding, then it is liable to mould slightly, but not enough to do any harm. It is frequently stored three weeks before it is consumed, and when kept that long it is tender and juicy—in other words, it is "ripe." You say that your meat tastes of pine. You did not state whether or not your cooler was a new one or not. If it is a new one and has been properly constructed it should not give meat a taste; if it has been made from boards not thoroughly dry it will cause meat to taste of pine and it might even be responsible for some mould. Then again the walls may have been stuffed with green pine sawdust, and this will cause trouble. It may be that your cooler is a home-made one, not properly constructed; perhaps the circulation is not right. You merely state that the meat moulds and tastes of pine, whereas you should have given full details. If you will send us a drawing of your cooler and full details we will be able to give you the cause of your trouble and the remedy as well.

CAUSE OF FAILURE IN CURING BACON.

Query.—T. K. writes: "We have been having trouble with our bacon. We put it down in second-hand lard tierces which we got from the large bakers here. We thoroughly cleansed them with boiling water before using them, and have been careful to weigh everything and measure the water we made the brine out of. We used brown sugar, the same as we have always used previous to this time. Our bacon was thoroughly cooled out before it was salted, and was never frozen. After being put in the pickle, we let it stand in the back part of the shop, where the temperature was often below freezing, but never cold enough to freeze the meat in the brine. We repacked it by moving from one tierce to another, always putting the same brine on the meat. We usually let our bacon in the brine for six weeks, unless it is very heavy, then we let it in a longer time. We usually keep four tierces full, and by moving from one to another always have the last one ready to take out and smoke. We used just the common barrel salt and have always had good results until now; in fact, this time the meat is perfectly sweet, but the fat of it is very dark colored, while heretofore it has always been nice and white. We do all our own killing. If you can tell us what we have done wrong, we would like to know, as we are always trying to improve whenever we can."

Ans.—You have been very fortunate indeed to have escaped trouble if you have always cured your bacon as you explain. There are many things which you have done while curing which are likely to cause you serious trouble, and which should never be done in the future. You are lucky that some of the meat did not spoil completely. It is never advisable to use lard tierces for curing, as the the lard is run into the tierces while hot, and the fat naturally soaks into the wood. This fat in time becomes rancid, and is likely to contaminate the brine and also the meat, even though you scald out the tierces, you do not get the grease out of the pores of the wood. It is always best and safest to use new tierces for curing purposes; in fact, there is great risk in using anything else. You should never use brown sugar for sweet pickle, but the very best grade of granulated sugar. Brown sugar is always more likely to contain foreign substances detrimental to the brine, and in most cases causes the brine to turn ropy, sometimes even causing it to ferment. The purest of sugar should always be used for sweet pickle. You have deviated from one of the greatest essentials to successful curing by not observing the most important of all requirements and that is an even temperature of about 38 degrees during the entire period of curing. You state that your meat was sometimes in a temperature below freezing point, but never cold enough to freeze the meat in the brine. Such a degree of

temperature is enough to ruin your meat, as the curing room should never be allowed to go below 36 degrees. The moment you get the temperature below 36 degrees, the meat ceases to take on salt and will not cure; besides, it is likely to spoil in the brine. It is all right to cure heavy Breakfast Bacon six weeks, but bacon from light or small hogs will cure perfectly in twenty to twenty-five days. The meat, however, at a temperature below freezing point would not cure in six weeks or even in a much longer time. We, of course, understand that the temperature in your curing room was not always below the freezing point, but it should never be that cold.

HOW TO TREAT PORK WHICH IS TOO SALTY.

Query.—F. B. writes: "We have about twenty barrels of pork that have become very salty in the brine. What would you do and how can we get the brine out?"

Ans.—Salt pork is usually put down in very strong brine, therefore it is perfectly proper that pickled pork should be very salty. If it is desired to store the pork for a long time, it should be left in the strong brine and in order to freshen it so that it will not be so salty, the pork should be washed in fresh water. It is best to handle one barrel at a time as it is to be sold or used in the market. The water in which the pork is soaked should be as cold as possible; in fact, it would do no harm to put a little ice in it. By allowing the pickled pork to soak in the fresh water, a great deal of the salt will be drawn from the meat. The meat should be soaked twenty-four hours altogether, and during the daytime the water should be changed every six hours. After the meat has been soaked, it can be placed in a mild brine, which should not be over 40 degrees strength, but if the meat can be disposed of in a few days, it is not necessary to keep it in the brine at all. It will be sufficient to place it on a shelf in the ice box; at the end of three or four days, it might be necessary to wash it off with fresh water.

KEEPING CURED MEATS IN CELLARS DURING SUMMER.

Query.—We have not enough cooler room to cure meat during the summer time, and we want to know if there is any way we can keep cured meat in our cellar during June weather without it becoming too salty.

Ans.—Even if you cure the meat in the winter and keep the cooler at a proper temperature and then leave the meat in the brine during the summer, the brine will turn sour, or become ropy, or thick, and will spoil the meat. To store meat in brine, it is absolutely necessary to keep it at a very low temperature. In fact, it is necessary to have an ice machine to keep the temperature in the cooler or storage room as low as 30 degrees. You could get it as low as 28 degrees. The meat would not freeze, but by having the temperature so low, the meat would not take on any more salt. You seem to be of the opinion that if the pickle on the meat were reduced you could keep the meat in the brine and keep it in a warm temperature. That would be impossible. Of course, having the brine weaker, it would not cause the meat to become so salty, but nevertheless, the brine would spoil, and it would then spoil the meat. To store meat in brine it is absolutely necessary to have the proper facilities and that means an ice machine. Our advice is that you cure enough meat during the winter according to the **Freeze-Em-Pickle** process to carry you until the middle or end of May, and then about the first of May begin curing some more meat in your regular cooler where the temperature is low enough so that the meat will cure properly.

STRONG LARD FROM BOARS.

Query.—J. A. S. writes: "I have rendered 100 lbs. of lard made as follows: 75 lbs. from fat barrows, 25 lbs. from fat boars. I find that the lard is strong. Can you give me the cause of it?"

Ans.—The odor from boar fat is so strong that such fat should not be used in first grade lard. Boar fat will only make a second grade of lard. We advise that you always keep it separate and sell it at a discount as a second grade of lard to bakers. The strong boar odor cannot be removed from the lard and the only thing that can be done is to whiten and purify it. In future render your barrow fat and boar fat separately.

TO MAKE HEAD CHEESE AND NEW ENGLAND STYLE HAM SOLID

Answer.—To make **Head Cheese** sticky and solid without putting hog rinds in it, use Bull-Meat-Brand Sausage Binder, putting from ten to twelve pounds of Bull-Meat-Brand Sausage Binder into 100 pounds of meat. The quantity used must be governed by the percentage proportion amount allowed by your State Pure Food Law. This will make a firm, solid Head Cheese, filling all the holes with a jelly-like mass. Bull-Meat-Brand Sausage Binder is an excellent binder for Head Cheese and other sausage products.

If you desire your New England Style Ham to be more sticky, you must take your pork trimmings and cut them about the size of an egg and mix with every 100 pounds of meat 1 pound of our **Freeze-Em-Pickle,** but do not put any salt with them whatsoever. Let the meat stand in the cooler for a week and you will find that the juices in the meat will have been thickened like glue and be sticky. Then take the meat out of the cooler; add 1½ pounds of salt to 100 lbs. of meat and season with Zanzibar-Brand Seasoning. Take a small quantity of this meat and grind it very fine and then mix the fine with the coarse pieces and stuff it. Cook it very carefully with slow heat, then put it in the cooler in a press or put boards on it and press it down with stones. Your New England Style Pressed Ham is then finished. Of course, you can use some Zanzibar-Carbon to color the casings. See directions for momentary dipping on page 83.

HOW TO PREVENT MOULD ON SAUSAGE, HAMS AND BACON.

Query.—L. B. writes: "Will you please let me know if there is anything to prevent the moulding of summer sausage, hams and bacon?"

Ans.—It is first necessary that you hang the sausage and meat in a dry, cool room. If you keep it in a room where the air is moist, it will mould rapidly. If lard is rubbed on the sausage and also the meat, it will aid materially in preventing moulding. When so used, it should be applied with a cloth and rubbed on both the meat and the skin side. If your meat has already begun to mould, it should first be washed with warm water and then permitted to dry for a few hours. When dry apply a little of the lard with a cloth.

SHARPENING KNIVES AND PLATES OF MEAT GRINDERS.

Query.—F. W. F. Co. asks how to sharpen knives and plates of meat grinders.

Ans.—If the plates are grooved and rough, it will be necessary to have them turned off in a lathe. Then the knives should be sharpened on the cutting-edge just like a scissors. We do not mean the flat side which runs against the plate. But if the knife is also rough on the flat side, then the flat side should be smoothed off a little on a grindstone, and after the plate is turned down the knife should be ground with emery and oil right on the plate to make a tight fit. If you have no lathe, it will have to be done in a machine shop, and in that event we would advise you to get into touch with some of the large concerns which supply butchers' cutlery, etc. We would be pleased to give you the names of some very good firms if you desire.

HOW TO CURE MEAT FROM FARM-KILLED HOGS.

Query.—C. A. J. writes: I have more or less trouble in curing hams from farmer killed hogs. The trouble I have is in the marrow. Would you please tell me the best way for farmers to kill and chill hogs and how is best to cure such meat?

Ans.—We take pleasure in sending you by mail under separate cover, our book, "Secrets of Meat Curing and Sausage Making." This book will give you all needed information with reference to meat curing and sausage making. You should study this carefully because it gives you the needed information for handling the meat before it is put in brine and during the time it is in the brine. It tells you how to pump the meats; how to make the brine for pumping; when to overhaul the meat; the temperature to cure in, etc. If you will follow all information given in these articles you will overcome the trouble you have had. You should also use **Freeze-Em-Pickle** for curing because by its use you will be able to turn out the finest mild-cured sweet pickled meats having a most delicious flavor, of good appearance. Moreover you would have a uniform cure and no loss from sour meats. You say that you have had trouble from hams souring at the marrow. Read carefully our article relating to the pumping of meats. By pumping you will overcome the souring at the marrow.

CAUSE OF FAILURE IN CURING MEATS.

Query.—H. B. writes: I have been trying to cure corned beef, but it has a very funny taste. If you can tell me what is the trouble and how to avoid it I will be greatly obliged. I boil the water for making it into brine and use refrigerated meats. I thoroughly cleaned the barrel with scalding hot water. I did not cure the meat in a cooler, but in a room where the temperature runs from sixty to sixty-five degrees. The brine was seventy degrees strength, according to the pickle-tester. I did not use either sugar or molasses in the brine. The curing is a failure. Will you please give me all the information you can?

Ans.—Your questions are their own answers. It is impossible to cure Corned Beef or any other kind of meat in a room where the temperature is as high as 60 degrees. It should not be higher than 45 degrees, and 40 degrees will be much better.

We refer you to our directions for curing Corned Beef in our book, "Secrets of Meat Curing and Sausage Making."

The directions contained therein should always be followed to the letter, if good results are desired, and when they are followed you will turn out the very finest Corned Beef; it will be in perfect condition and have the sweet taste so much desired. The brine for 100 pounds of meat should be made as follows: 8 pounds of common salt, 1 pound of **Freeze-Em-Pickle**, 2 pounds of granulated sugar and 5 gallons of cold water. The meat should be cured in this brine ten to fifteen days, according to the weight and thickness of the pieces. Use only fresh meats that have been thoroughly chilled.

LARDING NEEDLES—HOW USED.

Query.—F. P. C. writes: What are larding needles used for? I would like to receive a copy of your book.

Ans.—A larding needle is used for drawing fine or thin strips of bacon through beef tenderloins and other kinds of meat. Frequently small strips of dry salt pork are drawn through beef tenderloins, also through meat to be roasted. This makes the meat nice and juicy and also imparts to it a fine flavor. The strips which are to be drawn through the meat are cut very thin and usually square. They are about ⅛ to 3-32 of an inch in thickness.

WHY COOLER "SWEATS."

Query.—F. B. writes: "I would like a little information in regard to my cooler. In sultry weather it sweats terribly, almost changing its natural finish to white and the sweat rolls down from it. If you can give me any information as to how I can stop it, I will be very thankful to you. The inside of the cooler is perfectly dry; in fact, I could strike a match in it anywhere. Kindly let me know if there is any way of preventing this trouble."

Ans.—The trouble with your cooler is no doubt due to the moisture of the atmosphere and to some imperfection in insulation. The defect can be remedied by the manufacturers. You say the cooler is perfectly dry inside, therefore, its construction must be very good, but the outside insulation is not just right, so the outside becomes too cool and the moist air coming in contact with the cold surface readily condenses. If the cooler can be insulated in such a way that the outside will not become so cold, we have no doubt your trouble can be overcome.

HOW TO GIVE A BRIGHT, RED COLOR TO BOLOGNA AND FRANKFORT SAUSAGE WITHOUT ARTIFICIAL COLORING.

Query.—I am trying to make Bologna and Frankfort sausage, and make it all right except the color of the meat. I cannot get a nice pink color.. I have tried Freeze-Em Pickle; it is all right, but it is too slow a process. I want to make my sausage out of fresh meat and smoke it in a smoke-house, but cannot get a nice pink color on the meat. It has a gray color and does not look right. I have a color on hand, but it don't give satisfaction. It makes the meat too red and does not look good.

Now, if you have anything that will overcome my trouble and will give my sausage a nice pink color, not red, and will comply with the National Pure Food Law, send it right along. I will remit on arrival. I would send the money now, but do not know the value of it. I make about twenty-five pounds of sausage at a batch.

Ans.—Your letter of recent date received. You say you are trying to make bologna and that you make it all right, but that the color of the meat is not a nice pink color. You say you tried the **Freeze-Em-Pickle** and that it worked all right, but that it is too slow a process. You further say you want to make your bologna out of fresh meat, but that you do not get a nice pink color when it is made that way. You say the meat is gray.

In all of that you are correct, and you will always have a gray sausage unless you make it with **Freeze-**

Em-Pickle according to the directions in our circular. If you make bologna sausage out of fresh meat, it, of course, will be gray. If you roast a piece of beef, it will be gray. If you cook a piece of beef, it will be gray. It is the same with bologna. When bologna is made with fresh meat, it will be gray, just as though you take a piece of fresh meat and boil it. It is impossible to make bologna with a pink color and make it out of fresh meat. For that reason, we recommend you to use **Freeze-Em-Pickle** and prepare your bologna meat with **Freeze-Em-Pickle** beforehand. You can do that in about two or three days. It is better, however, to let the meat cure for a week.

All you have to do is to trim out the beef and pork trimmings with which you intend to make the bologna, cut the pieces up about the size of an English walnut and sprinkle on **Freeze-Em-Pickle** in the proportion of one pound **Freeze-Em-Pickle** to every 100 pounds of meat. **Mix the meat thoroughly and then** pack it tightly in a tierce or a box, in fact a shallow box where the meat is not very thick is better, but pack it in tightly, and then put it in the cooler and let it remain there for at least four or five days, or a week, if possible. Then when you make bologna, the bologna will be better in flavor, will be juicier, will have a fine red appearance, and will be perfect in all respects. This we positively guarantee.

If you want to make bologna and frankfort sausage properly and have it right in all respects, you must take the necessary time and prepare the meat accordingly.

Formerly when artificial colors could be used in bologna and frankfort sausage, then it was all right to make it out of fresh meat and use an artificial inside color, but now, however, the food laws are such that you cannot use an inside color and therefore it is necessary to make it according to the **Freeze-Em-Pickle** process and with our **Freeze-Em-Pickle**. Then you will have a nice pink color on the inside of your bologna and frankfort sausage. You say you have a color on hand but it does not give satisfaction. It is a good thing that it does not give satisfaction, because if you were to use it, you could be arrested and fined and it would cause you a great deal of trouble; in fact, your reputation might be ruined if your name got in the papers stating that you used coloring on the inside of your bologna and frankfort sausage, because the food laws prohibit that.

By using the **Freeze-Em-Pickle** process you will make sausage that will in every way comply with your state food law and will at the same time, have a fine inside color, and excellent flavor and splendid keeping qualities. This will overcome all the troubles you mention, and all that is necessary is for you to prepare your meats a few days before hand. In fact, you can prepare a quantity of the meat before hand and keep it and use it along as you need it, making up 25 pounds at a time whenever you wish to do so, and leave the balance until a later occasion. Meat will keep this way in a good cooler indefinitely. This is the only way we can recommend your making sausage that will comply with your law and at the same time have the color you desire. Of course, it is a little more trouble, but it is trouble that will well repay you, because your sausage will really be of better quality and it will make a much better appearance.

HOW TO REMOVE WOOL FROM GREEN AND DRY SHEEP PELTS

Question.— K. M. Co. writes: Can you give us a method for pulling the wool from green hides and also from dry hides? We get the dead carcasses from the feed and transit yards—a good many hundred pelts during a year. Lots of these pelts are torn. If we can pull the wool we will be able to realize more money out of handling these pelts.

Answer.—As a general rule, wool is pulled from pelts by concerns that make this work a business. The method used is sweating and steaming the pelts. The pelts are hung on racks in a room into which live steam is turned. The pelts are kept hot for a number of days and the heat loosens the wool. It can then be easily pulled from the skin. The wool is then dried and baled.

You could not adopt this method profitably on a small scale, but we will give you a method that you can use which will prove a satisfactory way for small handdlers of pelts who desire to pull the wool.

Make a pile of your pelts, wetting the pelts as you pile them. Cover the pelts with blankets or gunny sacks and allow the pile of pelts to sweat. The wet pelts being covered up tight, will become hot and sweat. This will loosen the wool and it can be readily pulled off.

Another way of removing the wool from pelts is to spread the pelts upon the floor, with the wool down next to the floor. On the skin side of the pelts place crushed fresh lime and dampen the lime. This wetting of the lime will cause it to slake and soak into the skin. The wool will be loosened by this treatment of the pelts and it can be easily pulled. This method, however, will spoil the skins and render them of no value.

The simpler method of handling the green hides by a butcher or other dealer who has only a small business equipment is to use the sweating process. By this method both the wool and the skins can be saved and sold. Ordinarily, by the sweating method the pelts are piled one on top of the other, some water sprinkled on each pelt, and the piles made from two feet to three feet high, and allowed to sweat. Great care must be taken not to let the pelts sweat too much, otherwise the hide will decay and in pulling the wool the hide will tear. As soon as the wool is sufficiently loosened from the pelt it should be pulled. The skins can then be salted and cured, or the skins can be put into a brine and cured. After the skins are thoroughly cured they are ready to be shipped to the tannery.

HOW TO MAKE PEPPERED BEEF

Question.—G. E. O'F. writess—Can you furnish me with a recipe for making (Postromer) Peppered Beef? I am a user of your goods and will be under obligations to you for this information.

Answer.—We do not clearly understand your question. If you mean cured Briskets that are covered with red pepper, or Paprika Compound, and then smoked, you can proceed as follows:

Cure your boneless briskets in corned beef brine with garlic in it. You will find a formula for this in our book, "Secrets of Meat Curing and Sausage Making," a copy of which we are sending you. After the meat is cured, and before you place it in the smoke-house, rub our Chile Powder all over the out-

side of it, and then smoke it. Or, you can smoke it and cook it, and then rub the Chile Powder over it after it is cooked. In this way, you will use less Chile Powder.

UTILIZING FAT TRIMMINGS

Question.—H. A. writes: Please send me information as to how to use up my fat trimmings.

Answer.—The best way to make use of your fat trimmings is to work them up into Pork Sausage, using plenty of Bull-Meat-Brand Sausage Binder to absorb the fat. When plenty of Bull-Meat Sausage Binder is used the fat stays in the sausage when fried instead of frying out. This keeps the meat from shrinking.

B. HELLER & CO.

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The following are equivalents of some of Heller's commercial products.

Meat-Pickling Brine
Dutch Patent 62,273

Solution (a) *	122.90 cc.
Solution (b) **	77.10 cc.
Sodium Chloride	50.00 g.
Sodium Nitrate	1.25 g.
Sodium Nitrite	0.02 g.

This gives a fine red permanent color to meat.

* Solution (a)
Citric Acid 21 g.
Water 1 l.
** Solution (b)
Sodium Hydrogen Phosphate 35.6 g.
Water 1.0 l.

Meat Preservative
(For bacon, ham or sausage)
British Patent 354,025

Sodium Chloride	86
Sodium Nitrite	3½
Sodium Sulfate	1½
Magnesium Carbonate	1
Magnesium Chloride	1
Calcium Sulfate	1
Calcium Nitrate	1
Calcium Carbonate	½

Cure for Sausage Meat
Sodium Nitrate 3 lb. 7 oz.
Sodium Nitrite 5 oz.
Dextrose (Corn Sugar) 10 lb.

Place above ingredients in a 5 gallon container (preferably glass), fill with water and dissolve.

Use 1 quart of solution for each 100 pounds of meat.

This cure is referred to in all formulas given in this booklet and meets all federal and state regulations. Any other good cure may be used without impairing the quality of the finished product.

Meat Curing Salt
U. S. Patent 2,299,999

Magnesium Chloride	0.3–2.5
Water	0.5–3
Sugar	1–3
Sodium Chloride	To make 100

Pork-Sausage Seasoning

Ground Sage	5½
Savory	10½
Ground White Pepper	10½
Ground Black Pepper	11½
Ground African Ginger	5
Ground Nutmeg	3
Ground Cayenne Pepper	1

Preserving Lard
A sample of lard treated with 2 per cent Siam benzoin was in good condition after 18 months' exposure to air at normal temperatures, while untreated lard was rancid after three months.

Dried Salted Meat
British Patent 550,421

Minced lean meat is heated with 50 wt.-% of dilute hydrochloric acid (of such concentration that the pH falls to 1.5) so that it reaches 80°C. in 45 minutes, and is then neutralized to pH 6 with sodium hydroxide. The product is roller-dried to give a dried meat containing about 7% of sodium chloride.

Coating for Sausages

Paraffin Wax	35 g.
Rosin	62.8 g.
Whiting	2.2 g.

Glaze for Smoked Meats
A gelatin dip which is sometimes used on smoked meats to avoid mold and shrinkage is made of the following ingredients:

Commercial Gelatin	25 lb.
Glucose	35 lb.
Water	40 lb.

Place gelatin and glucose in a double boiler and mix, having temperature of water in bottom of boiler about luke warm. Then add 40 per cent water to gelatin and glucose, mix well and raise temperature gradually to not less than 130° F. and not over 150°. Cook for 1½ to 2 hours.

Wipe each piece of smoked meat carefully to remove surplus grease, salt, etc., then dip into glaze momentarily. If necessary, pieces may be dipped a second time. Then let them hang over dipping vessel so that any drip may be recovered. This glaze is transparent, resilient and amply tough to resist damage in reasonable handling. Meats may be wrapped and shipped in usual manner.

There are also glazes for covering meat loaves and sausage and for baked hams and picnics.

Sterilization of Meat Wrappings
Heating hessian wrappings at 65° for 1 hour gives practically complete control of low-temperature mold spores. Exposure for longer periods to somewhat lower temperatures (<50°) is also effective.

Tongue Pickling Solution

Salt Solution (70°)	100 gal.
Sugar	30 lb.
Sodium Nitrate	10 lb.

Meat Pickling Brine, Acid

Sodium Nitrite	0.9 lb.
Sodium Nitrate	0.6 lb.
Salt	97.65 lb.
Citric Acid, Anhydrous	0.85 lb.

Arresting Formation of Nitrite in Pickling Brine
Biological changes increase nitrite content and alkalinity of pickling brines on ageing. This can be controlled by the addition of 1½% magnesium carbonate with or without 1% magnesium chloride.

Ham Brine for Injection

Salt	240 g.
Sugar	30 g.
Potassium Nitrate	30 g.
Water	750 g.

Use the above amount for each kilogram of meat. Cover with salt mixture in customary way and smoke at 38-43°.

Meat Curing Salt
French Patent 818,943

Sodium Formate	1000 g.
Sodium Citrate	30 g.
Sodium Nitrite	2 g.

Meat Preserving Salt
Austrian Patent 145,089

Salt	91 g.
Potassium Nitrate	3 g.
Sugar	3 g.
Sodium Dihydrogen Phosphate	1– 2 g.

Removing of Boar or Sex Odor from Hog Meat
This odor is largely removed by using 1–500 sodium nitrate in 10% salt solution when pickling.

Seasoning and Condiment
U. S. Patent 2,021,403

Finely-granulated citric acid 22 oz. is heated with 66 oz. of table salt to 100° C. with continual stirring, until all the salt has been "wetted" by the acid. The mass is cooled slowly, the stirring being continued. Into the mixture are stirred powdered paprika 3.5 oz., white pepper 2.5 oz., and granulated sugar 6 oz. The product is non-hygroscopic.

Coloring and Flavoring for Meats
British Patent 425,567

Hæmoglobin, Defibrinated	100 oz.
Sodium Nitrite	5 oz.
Sodium Nitrate	1⅔ oz.
Water	100 oz.

Stir well for a few hours. Spray dry or vacuum dry. 1% of this product is used on meats.

Preserving Color of Meat
U. S. Patent 2,009,587

By coating freshly cut meat surfaces with a glycerin-gelatin-water solution containing a small amount of essential oil, the natural fresh color and appearance of the meat is maintained.

Spicy Flavors

Spice Meat Extract

Mace Extract	¾
Clove Extract	⅛
Thyme Extract	¾
Basil Extract	¾
Shallott Extract	7
Celery Extract	4

Spice Sausage Extract

Savory Extract	1
Pimenta Extract	2
Pepper Extract	5
Onion Extract	6
Bay Laurel Extract	⅛

Spice Smoked Meat Extract

Savory Extract	1
Cardamom Extract	½
Basil Extract	2
Pepper Extract	4
Garlic Extract	8

Meat Curing Brine

Sodium Chloride	3 lb.
Granulated Sugar	4 oz.
Sodium Nitrate	2 oz.
Sodium Nitrite	¼ oz.

Enough for 100 pounds of meat.

Seasoning and Condiment
U. S. Patent 2,021,403

Finely-granulated citric acid 22 oz. is heated with 66 oz. of table salt to 100° C. with continual stirring, until all the salt has been "wetted" by the acid. The mass is cooled slowly, the stirring being continued. Into the mixture are stirred powdered paprika 3.5 oz., white pepper 2.5 oz., and granulated sugar 6 oz. The product is non-hygroscopic.

Egg Preservative
British Patent 409,623

Eggs are coated with following:

Soft Yellow Paraffin	75 oz.
Tallow	5 oz.
Boric Acid	20 oz.

Meat Curing Salt
U. S. Patent 1,976,831

Mix together in an aluminum vessel

Sodium Nitrite	1½ lb.
Sodium Nitrate	1 lb.

Melt while stirring. Pour on metal plate to solidify. Pack in air-tight tins.

For treating 100 lb. of beef use ½ oz. of above ground into 3 lb. of salt.

Preventing Mold on Stored Meats

The humidity of the cooler should be 90 to 92% and the temperature 38–39° F. Ozone is introduced until it is present in 2.3 to 2.5 parts per million. This is continued for 2 hours and again for 2 hours after a lapse of 12 hours. After an interval of 30 minutes, workmen can safely enter the room.

Coating for Salamis
Formula No. 1

Paraffin Wax	35 g.
Rosin	62.8 g.
Whiting	2.2 g.

Applied at about 90° C.

Pork Sausage Flavors
For each 100 lb. of meat use:

Formula No. 1

Salt	2 lb.
Refined Corn Sugar	7 oz.
Nutmeg	2 oz.
Jamaica Ginger	½ oz.
Rubbed Sage	1½ oz.
White Pepper	6–7 oz.

No. 2

Salt	2 lb.
Refined Corn Sugar	6 oz.
Black Pepper	3 oz.
Jamaica Ginger	2 oz.
White Pepper	1 oz.

No. 3

Salt	2 lb.
Refined Corn Sugar	6 oz.
Mild Chili Pepper	1 oz.
Black Pepper	2 oz.
Rubbed Sage	3–4½ oz.

About ¾ oz. savory and ¼ oz. cardamon may be added to No. 1 and 2 formulas with good results. Some processors prefer to use only white pepper in pork sausage because of the darkening which results from the use of black pepper.

Coating for Sausages

Paraffin Wax	35 g.
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Glaze for Smoked Meats

A gelatin dip which is sometimes used on smoked meats to avoid mold and shrinkage is made of the following ingredients:

Commercial Gelatin	25 lb.
Glucose	35 lb.
Water	40 lb.

Place gelatin and glucose in a double boiler and mix, having temperature of water in bottom of boiler about luke warm. Then add 40 per cent water to gelatin and glucose, mix well and raise temperature gradually to not less than 130° F. and not over 150°. Cook for 1½ to 2 hours.

Wipe each piece of smoked meat carefully to remove surplus grease, salt, etc., then dip into glaze momentarily. If necessary, pieces may be dipped a second time. Then let them hang over dipping vessel so that any drip may be recovered. This glaze is transparent, resilient and amply tough to resist damage in reasonable handling. Meats may be wrapped and shipped in usual manner.

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Meat Curing Salt
French Patent 818,943

Sodium Formate	1000 g.
Sodium Citrate	30 g.
Sodium Nitrite	2 g.

Meat Preserving Salt
Austrian Patent 145,689

Salt	91 g.
Potassium Nitrate	3 g.
Sugar	3 g.
Sodium Dihydrogen Phosphate	1–2 g.

Removing of Boar or Sex Odor from Hog Meat

This odor is largely removed by using 1-500 sodium nitrate in 10% salt solution when pickling.

SMOKED POULTRY

Birds for production of smoked poultry should be killed by piercing the brain and bleeding, followed by any method of picking which will cause a minimum of injury to the skin surface of the bird. In drawing, great care should be taken to avoid rupturing the intestines and subsequent contamination of the body cavity with the intestinal contents. The deposition of large numbers of microorganisms in the body cavity, which may later cause off-flavors and difficulty in the pickling process, is thus prevented.

Following evisceration, it is well to wipe out the body cavity with a paper towel. This tends to absorb any leakage or excess moisture which may remain. A better cure in the pickle as well as a more thorough smoke is obtained if the bird is split down the back before immersing it in the pickle. From a sales standpoint the halved bird is an added advantage, since if it seems desirable to sell either a whole or a half bird, the quantity in each part can be controlled.

Poultry Pickling Solution

Water	5 gal.
Salt	4 lb.
Sugar	30 oz.
Celery Oil	8 cc.
Black Pepper Oil	8 cc.
Parsley Leaves Oil	8 cc.
Sage Oil	5 cc.
Thyme Oil	5 cc.
Marjoram Oil	5 cc.
Bay Leaves Oil	6 cc.
Sweet Basil Oil	6 cc.
Coriander Oil	5 cc.
Cardamon Oil	5 cc.

These oils are dissolved together in 200 cc. of ethyl alcohol. To prepare 5 gal. of pickle, 4 lb. of salt and 30 oz. of sugar are used. Twenty-two cubic centimeters of the alcoholic solution of essential oils is added to a small amount of the

sugar, together with about one gram of gum tragacanth, and the whole thoroughly mixed with a mortar and pestle. The remainder of the sugar and salt is dissolved in 5 gal. of water to which the essential oil-sugar-tragacanth material is added slowly with constant stirring. Properly prepared, the pickle should have a cloudy appearance.

LEATHER, SKINS, FURS

Hide Depilatories

The simplest way to make a depilatory paint is to mix hydrated lime, slaked lime (carefully sieved) with enough sodium sulphide solution (26° Tw.) to make a smooth working paste. The skins should be laid out on a rough table and painted with a white wash brush so that an even coat of depilatory is given to the flesh. Care must be taken to prevent the wool being smudged with the depilatory and badly damaged. When painted, the skins need doubling up down the back and then stacking in piles, two to three feet high, and leaving for 12 to 24 hours. The piles should not be too high as otherwise heat will be generated and the skins damaged. The work of painting, folding and stacking requires a good deal of care and should be entrusted to intelligent men under the supervision of the foreman. It is advisable to arrange the work so that pulling or rubbing can take place the following morning. The wool must be kept clean and when a sufficient quantity has been collected it should be well washed, hydro-extracted for a few minutes and then dried off completely. Hydro-extracting may remove some of the valuable woolgrease and the running time must be regulated to prevent undue loss.

Instead of sodium sulphide, realgar or sulphide of arsenic may be used, and it is particularly suitable for gloving lambs, goatskins for glace, and certain grades of calf. It is claimed that the use of arsenic depilatories, also arsenic limes, results in a finer grain.

A good arsenic paint may be made as follows:

Quick Lime	100 lb.
Red Arsenic	20 lb.
Boiling Water	50 gal.

Tip the lime into a large size tub and pour over it just sufficient water for it to slake vigorously. When this has continued for half an hour add the arsenic and the remainder of the boiling water. Stir well for several hours and then allow to cool. Next day use the solution for painting; if too thick add some water, or if too thin, then add a few pounds of slaked lime. It is advisable to run the thin paste through a coarse sieve so as to remove any unslaked lumps of lime likely to burn holes in the skins. When handling arsenic compounds it is very necessary to exercise great care to prevent accidents. The men should be provided with rubber gauntlet gloves, and the preparation of the arsenic-lime depilatory carried out in the open air.

Depilatory action is always quicker and cheaper if it can be carried out by immersion in a strong sulphide solution, but this method is not practicable if the hair or wool is of any value. A depilatory lime may contain from one to two per cent sodium sulphide crystals and three to five per cent lime on the hydro-extracted weight of stock. The best plan is to slake the lime in a pit by just covering it with sufficient water to enable it to work vigorously over a period of twelve hours. At the end of that time the desired volume of water should be added and the liquor well plunged up or agitated by some mechanical means. Agitation by means of compressed air is a most efficient and economical means of agitation. To ensure the best results it is advisable to stir up the lime liquor either by hand plunging or other means, add the sulphide solution (26° Tw.) and then agitate the liquor again for the same length of time. This may seem like double and unnecessary work, but in practice it proves well worth while. The skins should be thrown into the liquor one by one and pushed under the surface with a long pole. Some tanners allow the goods to remain for six hours for drawing, others only two hours, but all manner of variations are capable of good results.

Unhairing of Hides and Skins

Formula No. 1

U. S. Patent 2,016,260

Skins are immersed in aqueous sodium sulphide the pH of which has been adjusted to 11.8—12.2 by addition of an acid salt, washed, and subsequently immersed in milk-of-lime.

No. 2

German Patent 632,882

Sodium Sulphide	1	kg.
Quick Lime	2½	kg.
Salt	½	kg.
Water	10	kg.
Mixture:		
Potassium Hydroxide (40° Bé.) 1 kg. Alcohol 2 kg. Vegetable Oil 4 kg.	10–25	kg.

Pickling and Depickling Skins

For pickling sheep, goat and deer skins use for 100 kilograms of skins: water 125 litres, salt 9 kilograms, sulphuric acid 1 kilogram. Dissolve the salt, put the skins into the paddle, and while turning add the acid at intervals over an hour. For vegetable tanning skins should be depickled. For 100 kilograms of skins use: water 125–150 litres, salt 10 kilograms, sodium acetate 5 kilograms. Dissolve the salt, add the sodium acetate and paddle the skins for one-half hour and test the solution with bromcresol green. If the skins are sufficiently depickled the solution will remain green. If the action is insufficient the color will be yellow.

Pickling Lamb and Sheep Skins

An inexpensive pickle for sheep and lamb skins can be made by dissolving 100 lbs. of salt in 100 gallons of water and adding 12 lbs. of sulphuric acid to the solution. Use 12 to 15 gallons of this solution for each 100 lbs. of skins treated. Drum the skins for 30 minutes and then horse up to drain.

When firm skins are desired use 20 gallons of water, 20 lbs. salt and 2 lbs. sulphuric acid for each 100 lbs of skins.

For skins which come off of country dry pelts dissolve 85 lbs. of salt in 100 gallons of water and add 3 lbs. of sulphuric acid. Apply the solution by brush to flesh side of cleanly fleshed skins. Then place in piles and allow to remain from 12 to 48 hours depending on thickness of skins. When the hair of the pelts can stand immersion without damage, the pelts can be drummed from 6 to 24 hours in the solution instead of brushed.

Bleaching Leather

For chrome tanning:

Put pack of pickled stock into drum and add 5 lb. salt in 5 gal. water at 70° F. per 100 lb. pickled weight of stock. Run drum for five minutes and then add 1 lb. of potassium permanganate and 3 lb. of salt in 3 gal. of water at 70° F. per 100 lb. pickled weight. Run drum twenty minutes and add 1½ lb. sodium bisulphite and 1 lb. salt in 1 gal. water at 70° F. per 100 lb. pickled weight. Run drum five minutes and add 1 lb. sulphuric acid and 1 lb. salt in 1 gal. water at 70° F. per 100 lb. pickled weight and run 15 minutes. Remove the stock and repickle to equilibrium with same liquor as was used in the original pickling.

For vegetable tanning, the following formula is suggested:

Put pack of bated stock into drum and add 1 lb. of potassium permanganate and two-thirds of a lb. of sulphuric acid in 10 gal. water per 100 lb. bated weight. Run drum for twenty minutes. Then 2¼ lb. of sodium bisulphite in 2 gal. of water is added, followed by two-thirds of a pound of sulphuric acid in 1 gal. water. Drum 15 minutes.

The quantities of permanganate and sodium bisulphite used in bleaching can of course be somewhat varied to suit requirements. For fairly clean stock smaller quantities will prove sufficient; but for very dirty skins larger quantities may be necessary. Stock bleached with small quantities may be rebleached in the same manner without harm if found not to be perfectly clean.

The use of permanganate makes for better grading and increased selling value of the leather at a very small cost. Especially in the making of whites and light colors it would seem to be a necessity, although it is claimed it will improve the quality of any leather.

Deliming Skins

Italian Patent 323,555

100 kg. pelts are delimed with 200 kg. water, 2 kg. sodium sulphate and 0.2 kg. ammonium citrate during one hour, followed by washing with water.

Degreasing Bristles and Horse-Hair

Castile Soap	6–8	g.
Soda Ash	1–2	g.
Tetralin	0.8–1	g.
Ammonia (20° Bé.)	1–1.5	g.
Water	1	l.

The above is used per 100 g. of hair and is used at 25° C.

Continued from page 2326

TECHNO-CHEMICAL RECEIPT BOOK

1896

BITTERS, CORDIALS, ELIXIRS, LIQUEURS, RATAFIAS AND ESSENCES; EXTRACTS, TINCTURES AND WATERS USED IN THEIR MANUFACTURE, AND THE MANNER OF COLORING THEM.

Most of the bitters, cordials, liqueurs, etc., are produced in the cold way, either by mixing a solution of oil in alcohol with a warm solution of sugar in water, or by adding to this solution tinctures or essences, and diluting the mixture with the quantity of water required. As every cordial or liqueur appears turbid after mixing it, clarification becomes necessary. For ordinary qualities a solution of one-half ounce of alum in a pint of water for every 20 gallons of cordial can be recommended, and if this has not the desired effect, a solution of one ounce of soda in a pint of water may be added to the same quantity of cordial. But for the finer brands it is better to use a solution of 4 ounces of isinglass to a pint of water.

Mode of Coloring Cordials, Liqueurs, etc. Cordials and liqueurs should be colored after they have been filtered. A large number of cordials are not colored, especially anisette, bergamot, calamus, cardamon, caraway, fennel and maraschino.

Coffee, chocolate, curaçoa, nut, and most bitters are colored brown.

Barbadoes and orange blossoms cordials, dark yellow or orange.

Anise, lemon, orange and peach, pale yellow.

The cordials prepared from fresh herbs, green.

Cherry, gold water, raspberry, strawberry, rose and nutmeg, red. We have added the color required to most of our receipts.

I. COLORING SUBSTANCES. *Blue.* Dissolve ½ ounce of finely powdered Indigo in 2 ounces of sulphuric acid, and add 6 ounces of water to the solution.

Green. I. Boil 2 parts of liquid wash blue, 1 of powdered turmeric;

add some alum to the mixture and filter it.

II. To obtain a fine green, mix the tinctures of yellow and blue as given under their respective headings.

Purple. Boil archil in water, and add some alum.

Red. I. Crush ½ ounce of cochineal and 15 grains of alum; pour over the powder 8 ounces of boiling water and filter the fluid. The color is made darker or lighter according to the quantity of cochineal used.

II. Macerate 1 lb. of bilberries in 2 quarts of alcohol for 2 days, press the mass through a linen cloth and filter the fluid.

III. Macerate 3 ounces of finely powdered cochineal in 3 pints of alcohol for 2 days, then add ¼ ounce of powdered alum, and filter the fluid.

Yellow. I. Macerate 1 ounce of genuine saffron in 3 pints of alcohol, and then filter the fluid.

II. Take a quantity of marigolds according to the shade of color to be produced, steep them in alcohol, and filter the fluid, when it has assumed the desired shade of color.

II. ESSENCES, EXTRACTS, TINCTURES AND WATERS. *Absinthe Tincture.* Dissolve 2 fluid drachms of oil of wormwood, 1½ fluid drachms of oil of badian seed, 1¼ fluid drachms each of oil of anise seed, oil of fennel and oil of coriander seed; ¾ fluid drachm each oil of Crete marjoram (origan) and of oil of angelica, and 20 drops of oil of cardamon, 2 gallons of rectified spirits of 90 per cent. Tr.; dilute the solution with 2½ quarts of water, and color it green.

Ambergris Essence. Pour 12 fluid ounces of spirit of wine of 90 per cent. Tr. over 1 ounce of coarsely powdered ambergris, and let it stand for a few days. Then draw off the liquid, extract the residue with spirit of wine, filter the extract, and add it to the other portion.

Angelica Essence. Mix by shaking ½ fluid ounce of pure angelica oil with 1 quart of alcohol of 90 per cent. Tr.

Anise-seed Essence. Distil 1 pound of crushed anise seed, 1½ gallons of strong rectified spirit, and ½ pint of water. Add to this ¾ fluid ounce of anise seed oil and ½ gallon of rectified spirit, and clarify the mixture with 1 ounce of alum.

Anise-seed Extract. Dissolve by shaking 40 drops of anise seed oil, 4 drops of fennel oil, and 2 drops of coriander seed oil in 3 pints of rectified spirit of 90 per cent. Tr.

Anise-seed Tincture. Dissolve 2 fluid drachms of anise seed oil and 1½ fluid drachms of badian seed oil in 2 gallons of rectified spirit of 90 per cent. Tr.; dilute the solution with ½ gallon of water, and color it green, as above.

Aromatic Tincture. Comminute 6 ounces of zedvary, 4 ounces each of calamus root, galanga and angelica root, 2½ ounces of bay leaves, 2 ounces each of cloves, cinnamon blossoms and scraped orange peel, 3 ounces of Roman camomile, ½ ounce of ginger, and ½ ounce of mace. Pour 1¾ gallons of rectified spirit of 90 per cent. Tr. over the ingredients, and let them macerate for 8 days, then filter, and add 40 drops of oil of peppermint and 2½ quarts of water.

Barbadoes Essence. Mix 25 drops of oil of lemon, 25 of oil of bergamot, 6 each of oil of cinnamon, oil of cloves and oil of nutmeg, with 1 gallon of rectified spirit of 90 per cent. Tr., shake the mixture thoroughly, and filter it.

Bergamot Essence. Dissolve ¼ fluid ounce of oil of bergamot in ½ gallon of spirit of wine of 90 per cent. Tr.

Bitter Almond Essence. Crush 9 ounces of bitter almonds, place them into a still with 2½ gallons of water, let them macerate for 12 hours; then add 2¾ gallons of spirit of wine of 90 per cent. Tr., and distil off a distillate 75 per cent. strong.

Or, Pour 3¼ quarts of strong rye whiskey over 1 pound of crushed apricot kernels, 4 ounces of cherry kernels, 1 fluid drachm of cloves, and ½ fluid

drachm of mace, and distil off 3 quarts of essence of bitter almonds, or kernel extract.

Or, Dissolve 1 fluid drachm of oil of bitter almonds in 3 quarts of rectified spirit of 90 per cent. Tr., and store the fluid for some time before using it.

Bitter Essence (Single). Macerate ½ ounce of dried orange peel, ¼ ounce of calamus root cut in small pieces in 1¼ quarts of spirit of wine of 90 per cent. Tr. Let the mass stand for 2 days and then filter it.

Bitter Essence (Double). Comminute 2½ ounces of leaves of common buck bean, 1¾ ounces each of germander water, dried orange peel, and leaves of wormwood, and ½ ounce each of cinnamon and gentian root. Pour 1⅞ gallons of rectified spirit of 90 per cent. Tr. over the ingredients and let them digest for 2 days, when the fluid is drawn off and filtered.

Bitter Extract for Grünewald Bitters. Comminute 2 ounces of orange peel, ½ ounce each of gentian root, leaves of common buck bean, and galanga, ¼ ounce of leaves of blessed thistle, and 1 drachm of leaves of wormwood. Put the ingredients in a suitable flask, pour 1¼ gallons of spirit of wine 90 per cent. strong over them, place them in a warm place and let them digest. Then draw off the fluid, press out the residue, add the extract to the first fluid, and filter it through porous paper.

Calamus Tincture. Dissolve 1 fluid ounce of oil of calamus in 2 quarts of rectified spirit of 90 per cent. Tr.

Or, Comminute 15 ounces of calamus root and 1 ounce of angelica root. Pour 5 gallons of whiskey, 45 per cent. strong, over the roots, let them macerate for 2 days, and then distil off 3 gallons of essence 75 per cent. strong.

Caraway Essence (Cumin Essence). Pour 5 gallons of spirits of wine, 50 per cent. strong, over:

Crushed caraway seed	2 lbs.
Crushed anise seed	1 oz
Crushed fennel seed	1 oz.
Orris root cut in pieces	1½ oz.
Powdered cinnamon	½ oz.

Let the mass digest for 24 hours, and then distil off a distillate 85 per cent. strong.

Cardamon Extract. Peel and comminute 4¼ ounces of cardamons, pour 2½ pints of rectified spirit of 90 per cent. Tr. over them, add and mix thoroughly with it 1½ fluid drachms of oil of cardamon, and let the entire mass digest for 2 days, when the fluid is drawn off and filtered.

Or, Mix 1½ fluid drachms of oil of cardamon with 1¼ quarts of rectified spirit of 90 per cent. Tr. and filter the fluid through porous paper.

Cherry Extract. Press out the flesh of ripe cherries, let the mass stand quietly in a moderately warm room until the pure juice has separated from the pulp. Then place the mass in a bag, press the juice out, let it stand for a few hours longer, and add an equal quantity of rectified spirit of 90 per cent. Tr.

Cherry Water. Distil 5½ pounds of crushed cherry stones with 7¾ gallons of water, add 4½ to 5 gallons of cherries, and distil off 3 to 4½ gallons of cherry water.

Chocolate Essence. Pour 2½ quarts of spirit of wine over 12¾ ounces of roasted and ground cocoa beans, ½ ounce of powdered cinnamon, and ¼ ounce of powdered cloves; let the ingredients digest and filter the fluid.

Cinnamon Essence. Dissolve ½ fluid ounce of oil of cinnamon in 1¼ quarts of rectified spirit of 85 per cent. Tr., and filter the solution.

Clove Essence. Comminute 9 ounces of cloves, pour 1¼ quarts of rectified spirit of 90 per cent. Tr. over them, let them digest for a few days, and then filter the fluid.

Coffee Essence. Pour 1½ quarts of rectified spirit of 90 per cent. Tr. over 5¼ ounces of finely-roasted and ground coffee, let it digest for some time, draw off the fluid and filter it.

Cognac Essence. Dissolve 3½ fluid ounces of sulphuric ether in ⅛ gallon of alcohol of 90 per cent. Tr.

English Bitters Essence. Comminute ¾ ounce each of leaves of wormwood, leaves of centaury, and leaves of blessed thistle; ½ ounce each of gentian root, china root, and orange peel; ¼ ounce of orris root, and 1 ounce of grains of Paradise. Pour 1¼ quarts of rectified spirit of 90 per cent. Tr. over these ingredients, let them digest for some time, then pour the fluid off and filter it.

Fennel Essence. Dissolve 1 fluid drachm of oil of fennel, ¼ drachm each of anise seed oil and oil of lemon, and 10 drops of cumin oil in 1½ quarts of rectified spirit of 90 per cent. Tr.

Gold Water Essence. Dissolve 4 fluid drachms of oil of lemon, 2 fluid drachms of oil of orange, 1 fluid drachm each of rose oil, oil of nutmeg, and oil of cinnamon, ½ fluid drachm each of oil of calamus, oil of lavender, and oil of juniper, and ¼ fluid drachm of oil of cloves in ½ gallon of rectified spirit of 90 per cent. Tr., and filter the solution.

Herb Cordial Essence. Comminute ¾ ounce each of orange peel and lemon peel, ½ ounce of calamus root, ¼ ounce each of juniper berries, ginger, orris root, angelica root, and coriander seed, and 1 ounce each of galanga, leaves of marjoram, and leaves of rosemary. Pour 1 gallon of rectified spirit of 90 per cent. Tr. over these ingredients, let them digest for some time, then press out the fluid and filter it.

Juniper Berry Essence. Dissolve 1 to 1¼ fluid ounces of oil of juniper in 1¼ quarts of rectified spirit of 90 per cent. Tr. and filter the solution.

Or, Distil 1½ pounds of crushed juniper berries, 1½ ounces of bruised anise seed, and 3 ounces of powdered cinnamon, with whiskey sufficient to give a distillate of 3 gallons 75 per cent. strong.

Lavender Essence. Dissolve ½ fluid ounce of oil of lavender in 3½ quarts of rectified spirit of 90 per cent. Tr., and filter the solution.

Lemon Essence. Dissolve 2 fluid drachms of oil of lemon in 1½ quarts of rectified spirit of 85 per cent. Tr., and shake the solution thoroughly.

Mace Extract. Pour 3½ quarts of rectified spirit of 90 per cent. Tr. over 2 ounces of mace, let it digest for a few days, and then filter the fluid.

Marjoram Essence. Dissolve ½ ounce of oil of marjoram in 3½ quarts of rectified spirit of 90 per cent. Tr., and filter the solution.

Musk Essence. Pour 1¼ pints of rectified spirit of 90 per cent. Tr. over 1 drachm of powdered musk and ½ drachm of pulverized gray ambergris. Let the ingredients macerate for a few days and then draw off the clear fluid. Extract the residue with spirit of wine, filter the extract and add it to the first portion.

Nut Essence. Crush 50 large green walnuts, pour 1¼ gallons of rectified spirit of 90 per cent. Tr. over them, let them digest for a few days and press out the fluid. Distil the residue with sufficient whiskey to give a distillate 80 per cent. strong, and add this to the first essence.

Nutmeg Essence. Comminute 8¾ ounces of nutmegs, pour 6 gallons of rectified spirit of 90 per cent. Tr. over them, let them digest for a few days and then filter the fluid.

Orange Blossom Extract. Pour 1¼ pints of boiling milk over 10½ ounces of fresh orange blossoms; place the same on the fire and let it boil up; then add and thoroughly mix with it 3 quarts of rectified spirit of 90 per cent. Tr., and add 1¼ quarts of champagne to the filtrate.

Orange Blossom Water. Distil 11 pounds of preserved orange blossoms in 6 gallons of water, so that the distillate will amount to 3 to 3½ gallons of aromatic water.

Orange blossoms are preserved in the following manner: Put a handful of salt on the bottom of an earthen jar, place upon this a layer of orange blossoms, and repeat this alternately until the jar is filled. By keeping the jar in a cool place the orange blossoms will remain fresh for a long time. *Rose*

leaves are preserved in the same manner.

Orange Juice. Mix the juice of 12 or more oranges with 12 fluid ounces of rectified spirit of 90 per cent. Tr. When the sediment has all settled to the bottom, draw the fluid off and filter it.

Orange Peel Extract. Crush in a stone mortar the rinds of 12 oranges with some sugar, and let the mass digest for a few days by placing it in ½ gallon of rectified spirit of 90 per cent. Tr. Then decant the clear fluid and filter it.

Parfait D'Amour Essence. Dissolve ½ fluid ounce of oil of cinnamon, 6 fluid drachms each of oil of cardamon, oil of rosemary, and anise seed oil, and 20 minims each of oil of lemon, oil of orange, oil of cloves, oil of camomile, and oil of lavender in 1¼ quarts of rectified spirit of 90 per cent. Tr. Shake the solution thoroughly and filter it.

Peach Essence. Dissolve 1 fluid drachm of oil of bitter almonds in 3¼ quarts of rectified spirit of 90 per cent. Tr., allow the solution to stand for a few days, and then filter it.

Or, Crush 8¾ ounces bitter almonds, put them in a still, pour 2½ gallons of water over them, and let them digest for 12 hours. Then add 2¾ gallons of spirit of wine, and distil off a distillate 75 per cent. strong.

Peppermint Essence. Dissolve ¾ to 1 ounce of oil of peppermint in 2½ quarts of rectified spirit of 90 per cent. Tr.

Peppermint Essence may also be prepared by steeping 1 part of the leaves of the plant in 3 of spirit of wine 90 per cent. strong. After remaining in the spirit for 5 or 6 days, the clear fluid is poured off, the residue pressed, and the extract filtered and added to the clear fluid.

Quince Essence. Grate the quinces, press the juice out, add equal parts by weight of rectified spirit of 85 per cent. Tr.; let the mass stand until it settles and then filter.

Raspberry Extract. Crush 2 pounds of ripe raspberries, press them out and add 2 quarts of rectified spirit of 90 per cent. Tr.

Or, Take freshly picked raspberries, place them in an earthen dish, crush them to a pulp with a wooden spoon, and let this stand quietly in a moderately warm room until the pure juice has separated. Then place the pulp in a bag, press it out, let the juice stand for a few hours longer, and add the same quantity of rectified spirit of 90 per cent. Tr.

Raspberry Water. This is prepared from the residue left in preparing the extract by stirring it into a mash with water and distilling.

Rose Essence. Dissolve 2 fluid drachms of rose oil in 1¼ quarts of rectified spirit of 90 per cent. Tr., and filter the solution.

Rose Water. Preserved rose leaves are distilled in the same manner as given under *Orange Blossom Water.*

Rosemary Essence. Mix 6 fluid drachms of oil of rosemary with 1¼ quarts of rectified spirit of 90 per cent. Tr.; let the mixture stand for a few days and then filter it.

Sage Essence. Dissolve 1 fluid ounce of oil of garden sage in 1¾ pints of rectified spirit of 85 per cent. Tr.

Spanish Bitters Essence. Comminute 6 parts of calamus root, 3½ each of centaury and polypody root, 3 of orris root, 2 each of galanga, leaves of blessed thistle, elecampane root, and gentian root, and 1 each of leaves of wormwood, angelica root, and masterwort root. Pour 400 parts of rectified spirit, 90 per cent. strong, over the ingredients, let them digest for 48 hours, then press the fluid out and filter it.

Strawberry Extract. Bruise 4½ pounds of wild strawberries; pour 3 quarts of spirit of 90 per cent. Tr. over the mass; let it stand for some time and filter. The product will be about 1 gallon of strawberry essence.

Strengthening Tincture. Comminute 4¼ ounces each of gentian root, calamus

root, and oak bark, 2 ounces each of orange peel and angelica root, 1 ounce of cinnamon, and ½ ounce each of cloves and ginger. Pour 1¼ gallons of rectified spirit of 90 per cent. Tr., and 1¾ quarts of water over the ingredients, and let them digest for eight days. Then filter the mass, add 40 minims of oil of wormwood, and a like quantity of oil of peppermint and oil of balm to the filtrate.

Vanilla Essence. Cut 2½ ounces of vanilla beans, pour 1¼ quarts of rectified spirit of 90 per cent. Tr. over them; let them digest for some time, and filter the fluid. This essence should be kept in hermetically closed flasks.

Vanilla water may be made by pouring 1 gallon of water over the extracted residue.

Vanilla Tincture. Macerate ½ ounce of vanilla beans for 8 days in 2 fluid ounces of rectified spirit of 90 per cent. Tr., and filter the fluid.

Wormwood Essence. Comminute ¾ ounce each of leaves of wormwood, leaves of centaury, and leaves of blessed thistle, ½ ounce each of gentian root, china root, and orange peel, ½ ounce of orris root, and 1 ounce of grains of Paradise. Pour 2½ pints of rectified spirit of 90 per cent. Tr. over the ingredients, let them digest for some time, and filter the fluid off.

III. ELIXIRS. *Abbé Elixir.* Comminute 3½ pounds of lemon peel, 6¼ ounces of nutmeg, and a like quantity of cloves. Place the ingredients in a wickered demijohn, and pour 20 gallons of 33 per cent. alcohol over them, and let them digest for 3 to 4 weeks, placing the demijohn in a warm place. The mass is then strained through a cloth, the residue pressed out, the fluid filtered, and the filtrate compounded with a sufficient quantity of white sugar syrup.

Angel Elixir. Comminute and mix 4½ ounces of cinnamon, 2 ounces of galanga, 1½ ounces of cloves, 1 ounce each of nutmeg, orange peel, and lemon peel, ¾ ounce of ginger, ½ ounce each of orris root, zedvary, cubebs, and cardamons. Pour 3 pints of alcohol over the ingredients, and let them digest for 8 days. Then filter and add 2½ gallons of double distilled rose water, and 13 pounds of sugar syrup.

Elixir de St. Aur. Distil 9 ounces each of lavender blossoms, orange peel and rose leaves, 5½ ounces of lemon peel, 1 ounce each of cinnamon, cloves and nutmegs, with 5 gallons of alcohol and 4 gallons of water. Add 2½ quarts each of rose water, orange blossom water, balm water, and cinnamon water, and 30 pounds of sugar syrup to the distillate, and color it rose-red.

Elixir-Colombat. Dissolve 120 drops of oil of juniper, 40 each of oil of angelica, oil of wormwood, and oil lemon, and 20 of oil of cinnamon in 1½ gallons of alcohol; add 2¾ pounds of sugar dissolved in 1¼ gallons of water to the solution, and color it pale red.

Elixir of Life. Dissolve 2 fluid ounces of oil of wormwood and 1 fluid ounce each of oil of cardamon, oil of calamus, oil of nutmeg, and oil of orange peel, in 3½ gallons of alcohol 90 per cent. strong, and add ¾ of a gallon of water to the solution. Color the fluid brown with burned sugar.

Elixir Monpou. Dissolve 120 drops of oil of peppermint, 40 each of oil of balm, oil of orange peel, rose essence, and orange blossom essence; 32 each of oil of mace and oil of cloves, and 60 of vanilla tincture, in 1½ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with a syrup made of 7 pounds of sugar and 1¼ gallons of water. Color it rose-red.

Elixir des Troubadours. Macerate 2 pounds of musk roses, 1½ pounds of jasmine blossoms, 9 ounces of orange blossoms, 2½ drachms of mace in 3½ gallons of whiskey, 22 per cent. strong. Let the mass stand for 14 days; distil on the water bath, and add a syrup made of 11 pounds of sugar and 3 quarts of water. Color rose-red.

Elixir Vital. Dissolve 120 drops of

oil of bergamot, 32 each of oil of mace, oil of coriander seed, and oil of cloves; 24 each of cumin oil and oil of cinnamon, and 60 of vanilla tincture in 1½ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with a syrup made of 6½ pounds of sugar and 1½ gallons of water. Color green.

Juniper Elixir. Crush 4¼ ounces of juniper berries, pour 1 gallon of spirit 22 per cent. strong over them, and let them digest for 4 weeks. Then strain the fluid off, and add a syrup made of 9 pounds of sugar and 1½ quarts of water.

Tabourey Elixir. Comminute ¼ ounce of aloes, 2 ounces each of cinnamon and walnuts, 4¼ ounces each of orange peel and lemon peel, and 1 ounce of cloves. Pour 2¾ gallons of spirit of wine 33 per cent. strong over the ingredients, and let them digest for some time; then distil in a water bath, and add a syrup made of 13 pounds of pulverized sugar, and 1¾ quarts each of orange blossom water and rose water. This elixir is colored rose-red.

IV. Bitters, Cordials, Liqueurs and Ratafias. *Anise-seed Cordial.* Dissolve 2 fluid drachms of anise-seed oil and 20 drops of badian seed oil in 1¼ gallons of alcohol of 90 per cent. Tr. Compound this solution with 6¼ pounds of sugar in 1½ gallons of water, and filter.

Another Recipe. Dissolve 2 fluid drachms of anise seed oil, 40 drops of fennel oil, 32 drops of cummin oil, and 30 drops of oil of lemon, in 2¾ gallons of spirit of wine. Mix with this a solution of 8¾ pounds of sugar in 2¼ gallons of water, and store it away for 3 to 4 weeks. Then draw off the clear fluid, filter the sediment and color yellow.

Anisette Cordial. Dissolve 2 fluid drachms of anise seed oil and 18 drops of oil of bitter almonds in 1½ gallons of alcohol of 90 per cent. Tr.; add a solution of 5½ pounds of sugar in 1¼ gallons of water, and filter.

French Anisette. Dissolve 2 fluid drachms of anise oil, 20 drops of oil of bitter almonds, and 2¼ fluid ounces of cognac essence (see Essences) in 1½ gallons of alcohol of 90 per cent. Tr. Mix this solution with one of 5½ pounds of sugar in 1¼ gallons of water, and filter.

Holland Anisette. Dissolve 1 fluid drachm of anise oil, ½ fluid drachm of cognac essence, ¼ fluid drachm each of badian seed oil, oil of bitter almonds, and vanilla essence (see Essences), 1½ gallons of alcohol of 90 per cent. Tr. Mix the solution with one of 6 pounds of sugar in 1¼ gallons of water, and filter.

Angelica Cordial. Macerate the following ingredients in 4 gallons of alcohol of 90 per cent. Tr., and expose them to a moderate heat for 4 days:

Lemon peel	8 1/2	ounces.
Orange peel	5 1/4	"
Mace	1/2	"
Nutmeg	1/3	"
Cassia	2 1/4	"
Cloves	2	"
Orris root	1	"
Rosemary leaves	2	"
Lavender flowers	1 3/4	"
Marjoram	3/4	"
Orange flowers	2 1/4	"
Vanilla	1/2	"
Crushed juniper berries	2 1/4	"

Filter the mixture and compound the filtrate with a solution of 26 pounds of sugar in 2¾ gallons of water.

Aqua Bianca. Dissolve 30 drops of oil of lemon, 27 drops of cedar oil, 33 drops of oil of balm, 30 drops of oil of peppermint, ½ fluid drachm of vanilla essence, and ½ fluid drachm of ambergris essence (see Essences), in 1½ gallons of alcohol of 90 per cent. Tr. Compound the fluid with a solution of 6½ pounds of sugar in 1¼ gallons of water, and filter.

Aqua Reale. Dissolve 1 fluid drachm of oil of lemon, ¾ fluid drachm of oil of orange peel, 27 drops of oil of cinnamon, 30 drops of oil of cloves, 30 drops of oil of mace, 2 fluid drachms of vanilla essence, and ¾ fluid drachm of ambergris essence. Add to this solution one of 6½ pounds of sugar in 1 gallon of water, and filter.

Aqua-Turco Liqueur. Pour 2½ quarts of boiling water over 4¼ ounces of imperial tea, ½ ounce of green tea, 1 ounce of black gunpowder tea, 1½ ounces of strong infusion of lime blossoms, and ½ ounce of angelica seed. Close the vessel tightly to prevent the vapors from escaping, until the infusion has become cold. Then draw off the clear fluid and pour 2½ quarts of boiling water over the residue. Filter this infusion when cold and add it to the first infusion. Then add 28½ pounds of sugar and 2¼ gallons of rectified spirit of wine. Clarify the fluid with the whites of 3 eggs and 1¾ pints of sweet cream, and perfume it with some musk and spirit of ambergris. Finally, add 8½ fluid ounces of vanilla essence and let the fluid rest quietly for 24 hours. Then filter the liquor through a bag filled with animal or wood charcoal in order to obtain it entirely colorless.

Aromatic Cordial. Mix 30 drops of oil of lemon, 24 of oil of rosemary, 27 of oil of lavender, 30 of oil of peppermint, 27 of oil of angelica, 27 of oil of marjoram, and 33 of oil of cardamon with 1½ gallons of alcohol of 90 per cent. Tr. Shake thoroughly and then compound the solution with one of 5½ pounds of sugar in 1¼ gallons of water, and filter.

Ambergris Water. Macerate 2 drachms of powdered gray ambergris, 30 grains of powdered musk, 80 grains of civet in 1¼ pints of spirit of wine 40 per cent. strong, add ¼ ounce of refined sugar. Let the mixture stand for 14 days and then filter.

Berlin Bitters. Dissolve 80 drops of oil of juniper, 80 of oil of coriander, 40 each of oil of angelica and badian seed oil, and 44 drops of oil of ginger in 1½ gallons of alcohol of 80 per cent. Tr. To this solution add 1½ gallons of water and 1 pound of sugar. Filter and color brown.

Bitter-Rossoli. Comminute 8½ ounces of oranges and 4¼ ounces of sandal wood. Add 2¼ pounds of orange peel and 12 gallons of good rye whiskey. Let the mass digest for 14 days, then press, filter, and sweeten it with a solution of 3¼ pounds of sugar in 1 pint of water.

Breslau Bitter Cordial.

Cassia	1½	pounds
Cloves	5¼	ounces.
Mint leaves	4¼	"
Caraway seed	2	"
Fennel seed	4¼	"
Anise seed	8½	"
Coriander seed	2	"
Ginger	2½	"
Cubebs	2	"
Rosemary leaves	1½	"
Cardamons	4¼	"
Juniper berries	5¼	"
Lavender blossoms	1½	ounces.
Nutmegs	4¼	"
Roman camomile	3	"
Orris root	3	"
Angelica	6½	"
Oranges	6½	"
Orange peel	7½	"
Lemon peel	10½	"
Gentian root	4¼	"
Galanga	5¼	"
Calamus root	3	"
Wormwood	5¼	"
Alcohol of 90 per cent. Tr.	8	gallons.

Is sweetened with a solution of 58 pounds of brown sugar in 10 gallons of water and allowed to digest for 8 to 10 days, when it is filtered. This cordial is colored either dark yellow or dark red.

Calamus Liqueur. Macerate 9 pounds each of calamus root and of angelica root in 4¾ gallons of alcohol of 90 per cent. Tr., and let it stand for 6 days. Then filter the fluid, sweeten it with a solution of 22 pounds of sugar in 1½ gallons of water, and color it red.

Cardinal Water. Distil:

Fresh lemon peel	3.3	pounds.
Balm	5½	ounces.
Anise seed	4½	"
Coriander seed	4½	"
Cinnamon	8¾	"
Mace	2¼	"
Nutmeg	1	"
Alcohol of 90 per cent. Tr.	4¾	gallons.
Water	4	"

Dissolve 26¼ pounds of syrup in 5¼ gallons of water; add the solution to the distillate. Color sky blue.

Cardinal de Rome. Dissolve 2 fluid drachms of oil of lemon, 1 fluid drachm of oil of cloves, 40 drops of oil of nutmeg, 20 drops of oil of cinnamon, and 4 grains of gray ambergris in 3 gallons of spirit of wine, sweeten the fluid with a solution of 11 pounds of sugar in 2¼ gallons of water and filter.

Carminative Cordial. Distil:

Dried green orange peel	6½ ounces.
Dried green lemon peel	6½ "
Caraway seed	4½ "
Juniper berries	3¾ "
Anise seed	3¾ "
Camomile	3¼ "
Mint	2¼ "
Nutmeg	1 "
Alcohol of 90 per cent. Tr.	4¾ gallons.
Water	4 "

Add 27½ pounds of syrup and 3½ gallons of water to the distillate.

Capuchin Cordial. Dissolve 1½ fluid drachms of oil of parsley, 1 fluid drachm of oil of orange blossoms, 24 drops of oil of cinnamon, 1½ fluid drachms of cumin oil, and 20 drops each of anise seed oil, oil of mace, and fennel seed oil in 2 gallons of alcohol of 90 per cent. Tr.; sweeten the solution with a syrup made of 5½ pounds of sugar and 1½ gallons of water. Color brown.

Chartreuse. Three varieties of this liqueur, differently colored, are found in commerce. The following receipts can be highly recommended for manufacturing this liqueur.

	Green. Ozs.	Yellow. Ozs.	White. Ozs.
Mountain wormwood	1¾	¾	¾
Aloes		⅛	
Angelica seed	¾	¾	¾
Angelica root	½	¾	10 grains.
Arnica blossoms	⅛	⅛	
Buds of poplars	1		
Calamus root			¼ oz.
Cassia	⅛	⅛	¾ "
Cardamons		¼	¼ "
Coriander seeds		10½	
Tonka beans			35 grains.
Cloves		⅛	¼ oz.
Hyssop in bloom	2	1	¾ "
Nutmeg	⅛	⅛	¼ "
Mace			⅛ "
Balm	3½	1¾	¾ "
Peppermint	1¾		
Thyme	¼		
Spirit of wine of 85 per cent. Tr.	2¾ gl.	1¾ gl.	2½ gl.
Sugar	11 lb.	11 lb.	16½ lb.

Macerate the herbs in the alcohol for about 36 to 48 hours, add a quantity of alcohol equal to that of the distillate, and rectify the resulting product with the addition of an equal quantity of water. Then mix the distillate with the cold solution of the sugar, and add a sufficient quantity of water, so that the entire product will amount to 4½ gallons; then color the liqueur green or yellow.

Cherry Liqueur. Mix 1¾ gallons of cherry juice and 2¼ gallons of pure alcohol, and dissolve in the mixture ¼ ounce of Indian balsam, 1 drachm each of oil of cinnamon and oil of bitter almonds, and 35 drops of oil of cloves. Sweeten the solution with 13¼ pounds of syrup and 4½ pounds of white sugar dissolved in 4¾ gallons of water, and after shaking the fluid thoroughly store it away until it becomes clear.

Cherry Cordial. To a mixture of 4½ pounds of cherry juice and 3 quarts of alcohol of 80 per cent. add 16 drops of oil of cloves, 1 pound of sugar, and 3½ quarts of water, and filter the cordial.

Chocolate Liqueur.

Cocoa beans moderately roasted and crushed	3⅓ pounds.
Finest cassia	3¼ ounces.
Cloves	1¼ "
Vanilla	¾ "
Cardamons	½ "
Saffron	⅛ "
Cinnamon flowers	1¼ "
Alcohol of 90 per cent. Tr.	2¼ gallons.
Water	5¼ "
White sugar	28½ pounds.

Color dark red with cochineal.

Christofle. Dissolve 80 drops of oil of orange peel, 60 of oil of lemon, 40 of oil of cinnamon, 40 of oil of balm, 32 of oil of cloves, and 24 of oil of mace in 13 pounds of alcohol of 90 per cent. Tr., add a solution of 5½ pounds of sugar in 1½ gallons of water and filter.

Citronelle. Comminute 8½ ounces of

lemon peel, 3¼ ounces of orange peel, ¼ ounce of nutmegs, and ⅛ ounce of cloves. Pour 1¾ gallons rectified spirit of 90 per cent. Tr. over these ingredients and allow them to digest for 8 days, when they are pressed out and the fluid is filtered and compounded with a solution of 6½ pounds of sugar in 1½ gallons of water and the liqueur colored yellow.

Crambambuli. Mix 1 fluid drachm each of oil of cloves and oil of mace, ½ fluid drachm of oil of cinnamon, and 20 drops of oil of cardamon with 1¾ gallons of rectified spirit of 90 per cent. Tr. Sweeten the solution with a syrup made of 5½ pounds of sugar and 1⅛ gallons of water, and filter.

Danzig Crambambuli. Comminute 4¼ ounces of cinnamon, 1 ounce of cloves, ½ ounce of ginger, 1 ounce of mace, and ½ ounce of anise seed. Pour 2¾ gallons of rectified spirit of 90 per cent. Tr. over these ingredients, let them digest for 14 days, then press them out, filter the fluid, and sweeten it with a solution of 8¾ pounds of sugar in 2¼ gallons of water.

Cumin Cordial (Kümmel). I. Dissolve 2 fluid drachms of cumin oil and 4 fluid drachms of anise seed oil in 1¾ gallons of rectified spirit of 90 per cent. Tr., and sweeten the solution with a syrup made of 6½ pounds of sugar and 1½ gallons of water.

II. 1¼ fluid drachms of cumin oil, 24 drops of oil of coriander seed, 24 drops of oil of orange peel, 24 drops of cognac essence. Treat and sweeten in the same manner as No. I.

III. Dissolve 1¼ fluid drachms of cumin oil, 24 drops of fennel oil, 12 drops of oil of cinnamon, in 1½ gallons of rectified spirit of 90 per cent. Tr. Sweeten the solution with a syrup made of 1½ pounds of sugar and 1½ gallons of water, and filter.

Cumin Liqueur. Macerate for 6 days 1 pound of caraway seed, 1 ounce of anise seed, ½ ounce of orris root, ½ ounce of cinnamon, ¼ ounce of angelica root, ⅛ ounce of cloves, in 2½ gallons of alcohol of 90 per cent. Tr. Sweeten the solution with a syrup made of 11 pounds of sugar and 2 gallons of water, and filter.

Curaçoa. Comminute 1 pound of fresh orange peel, ¼ ounce of nutmegs, 2 ounces of cinnamon. Pour 2 gallons of rectified spirit of 90 per cent. Tr. over them, allow them to digest for 8 to 10 days, and compound the filtered fluid with a solution of 6½ pounds of sugar in 1½ gallons of water.

French Curaçoa. Dissolve 1¼ fluid drachms of oil of orange peel, 20 drops of oil of cinnamon, 12 drops of oil of mace, 30 drops of vanilla essence, 30 drops of raspberry essence, and 4¼ fluid ounces of Jamaica rum in 1¾ gallons of rectified spirit of 90 per cent. Tr., and add a solution of 6½ pounds of sugar in 1½ gallons of water.

Holland Curaçoa. Dissolve 1¼ fluid drachms of oil of orange peel, 20 drops of cognac essence, 8 drops of oil of lemon, 10 drops of oil of mace, and 1 fluid drachm of vanilla essence in 1¾ gallons of rectified spirit of 90 per cent. Tr., and compound the fluid with a solution of 6½ pounds of sugar in 1½ gallons of water. Color the liquor light brown.

Eau Americaine.

Orange peel	1	pound.
Rosemary leaves	4½	fluid oz.
Lavender blossoms	4½	"
Cinnamon	3⅓	"
Cloves	2¼	"
Nutmegs	1	"
Alcohol of 90 per cent. Tr.	4¾	gallons.
Water	4	"

Add to the distilled fluid 3 gallons of water and 26 pounds of syrup, and color the distillate green.

Eau D'Amour. Distil:

Bitter almonds	13¼	ounces.
Fresh lemon peel	13¼	"
Cinnamon	6½	"
Mace	1	"
Cloves	½	"
Lavender blossoms	9	"
Alcohol of 90 per cent. Tr.	4¾	gallons.
Water	4	"

Then add 1¾ gallons of Muscatel wine, 37 drops of ambergris essence, 22 pounds of syrup, and 1½ gallons of water, and color the fluid rose-red.

Eau D'Argent. Distil:

Fresh lemon peel	1	pound.
Cloves	2¼	ounces.
Angelica seed	1¾	"
Badian seed	1¾	"
Florentine orris root	1¾	"
Cinnamon	2¼	"
Alcohol of 90 per cent. Tr. . . .	4¾	gallons.

Add to the distillate 1¾ quarts of balm water, 26½ pounds of sugar syrup, and 2¾ gallons of water. Color the fluid red, and mix some silver leaf macerated with honey with it.

Eau D'Ardelle. Distil 4½ ounces each of mace and of cloves, 4¾ gallons of alcohol of 90 per cent. Tr., and 4 gallons of water. Mix with the distillate 3¼ gallons of syrup and 2¾ gallons of water, and color violet.

Eau D'Absynth Citronné. I. Distil 4½ pounds of wormwood leaves, ¾ ounce of lemon peel, 4¾ gallons of alcohol of 90 per cent. Tr., and 4 gallons of water. Add to the distillate 1¼ fluid drachms of oil of peppermint, 26½ pounds of syrup, and 3¼ gallons of water.

II. Dissolve 1¼ fluid drachms of oil of lemon, ¾ fluid drachm of oil of wormwood, 24 drops of oil of peppermint, 15 drops of anise seed oil, 1¼ fluid drachms of oil of cardamon in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten with a solution of 5½ pounds of sugar in 1¼ gallons of water, and color green. The same quantity of oil of orange blossoms may be used instead of cardamon oil.

Eau De Cypre. Dissolve 1¼ fluid drachms of oil of lemon, 30 drops of oil of bergamot, 20 drops each of oil of cinnamon, oil of orange blossoms and of vanilla essence, and 24 drops of oil of cardamon in 1¾ gallons of rectified spirit of 90 per cent. Tr., and sweeten with a solution of 6½ pounds of sugar in 1½ gallons of water. The liquor is left either colorless or colored pale yellow.

Eau de Dauphin. Dissolve 5 drops of oil of juniper, 20 drops each of angelica oil, coriander oil, and oil of ginger, 10 drops of oil of cardamon, and a like quantity of badian seed oil in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten by adding a solution of 3½ pounds of sugar in 1½ gallons of water, and filter.

Eau de Napoléon. Distil:

Fresh jasmine blossoms	6½	ounces.
Fresh lemon peel	11	"
Cloves	3¼	"
Cinnamon	3¼	"
Nutmegs	2¼	"
Alcohol	5	gallons.

Then add to the distillate: 2 fluid drachms of vanilla essence, 3½ quarts of double distilled rose water, 3½ quarts of orange flower water, 1¾ quarts of peppermint water, 3 pounds of sugar syrup, 3½ quarts of water, and color blue.

Eau D'Orient. Distil:

Fennel	1	pound.
Dates	¾	"
Lemon peel	¾	"
Orange peel	¾	"
Pine apples	¼	"
Grains of Paradise	2	ounces
Calamus	2¼	"
Allspice	2	"
Alcohol of 90 per cent. Tr. . . .	4¾	gallons.
Water	4	"

Add to the distillate 2½ gallons of sugar syrup and 5¼ gallons of water, and color blue.

Eau D'Or (Gold water). Dissolve ¾ fluid drachm of oil of lemon, 24 drops of oil of cinnamon, 24 drops of oil of coriander, 20 drops of oil of mace, 15 drops of oil of orange blossoms in 1¾ gallons of rectified spirit of 90 per cent. Tr., and sweeten by adding a solution of 7 pounds of sugar in 1¾ gallons of water. Color the fluid pale yellow, filter, and add a small quantity of finely macerated gold leaf.

Eau de Paradise (*Paradise Water*). Distil:

Fresh lemon peel	2¼ pounds.
Angelica root	3¼ ounces.
Orris root	2 "
Calamus	2¾ "
Anise seed	2¾ "
Rosewood	2 "
Cardamons	1 "
Alcohol of 90 per cent. Tr.	4¾ gallons.

Add to the distillate 26½ pounds of sugar syrup and 3 gallons of water. Color green and add some silver leaf rubbed fine.

Eau des Princesses. Dissolve 80 drops of oil of lemon, 80 of oil of bergamot, 40 of oil of cloves, 40 of oil of balm, 20 each of oil of cinnamon, oil of bitter almonds, and oil of peppermint, 60 of vanilla essence, and 40 each of rose essence and orange blossom essence in 2 gallons of rectified spirit of 90 per cent. Tr., sweeten with a solution of 7¾ pounds of sugar in 1½ gallons of water, and filter.

Eau Precieuse. Comminute 4¼ ounces of rosewood and a like quantity of bitter almonds, and let the mass digest for 6 to 10 days in 3 gallons of rectified spirit. Then press out, filter, and add to the filtrate 20 drops of oil of cloves, 12 of oil of lemon, and 12 of oil of nutmeg, and also a solution of 8¾ pounds of sugar in 2¼ gallons of water. This liquor is colored green, and a small quantity of silver leaf macerated in alcohol is added.

Eau Royale. Distil:

Lemon peel	11 ounces.
Orange peel	11 "
Jasmine blossoms	8¾ "
Mace	4½ "
Cinnamon	4½ "
Cloves	2¼ "
Nutmeg	1 "
Alcohol of 90 per cent. Tr.	4¾ gallons.
Water	1¾ "

Add to the distillate 20 drops of ambergris essence, 2 fluid ounces of vanilla essence, a like quantity of orange flower water, 2½ gallons of water, 26½ pounds of sugar syrup, and color the fluid red.

Eau de Santé. Mix 4 fluid drachms of oil of lemon, ¾ fluid drachm each of oil of rosemary, oil of lavender, oil of peppermint, oil of angelica, oil of marjoram, and oil of cubebs, and 13¼ pounds of sugar in 3 gallons of rectified spirit of 90 per cent. Tr. Color the solution green and filter.

Eau de Sept Graines (*Water of Seven Seeds*). Comminute ½ ounce each of anise seed, fennel seed, caraway seed, and coriander seed, and 6 grains each of dill seed and of wild thyme seed. Macerate the seeds for about 14 days in 3½ quarts of French brandy, then filter, and sweeten with a solution of 2¾ pounds of sugar in ¾ of a pint of water.

English Bitters. I. Compound 4¼ ounces of English Bitters essence (see *Essences*) and ¾ fluid drachm of cognac essence; sweeten the liquid with a solution of 4½ pounds of sugar in 1¼ gallons of water, filter, and color brown.

II. Compound 80 drops of oil of orange peel, 60 of oil of angelica, 40 of oil of wormwood, 24 of oil of marjoram, and 16 of oil of cardamon with 1¾ gallons rectified spirit of 90 per cent. Tr.; sweeten the solution with 5½ pounds of sugar in 1½ gallons of water, filter, and color brown.

Greek Bitters. Dissolve 80 drops of oil of lemon, 48 of oil of wormwood, 40 each of oil of angelica and oil of calamus, 24 each of oil of mace, oil of cloves, oil of bitter almonds, and 12 of cardamon oil, in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten this solution with a syrup of 6 pounds of sugar and 1½ gallons of water, filter, and color reddish brown.

Hamburg Bitters. Dissolve 120 drops of oil of cinnamon blossoms, 40 each of oil of cloves, oil of calamus, and oil of wormwood, 24 of oil of mace, and 20 of oil of cardamon, in 1¾ gallons of rectified spirit of 90 per cent. Tr., and add a solution of 5¼ pounds of sugar in 1¼ gallons of water; filter the fluid and color it brown.

Juniper Liqueur. I. Compound 2 fluid drachms of oil of juniper and 24

drops of oil of cardamon with 1¾ gallons of spirit of 90 per cent. Tr.; sweeten the mixture with a solution of 5½ pounds of sugar in 1½ gallons of water, and filter the fluid.

II. Dissolve 2 fluid drachms of oil of juniper, 24 drops of oil of ginger, 24 drops of oil of coriander, and 1¼ fluid drachms of cognac essence in 2 gallons of rectified spirit of 90 per cent. Tr., and sweeten the solution with 5½ pounds of sugar dissolved in 1½ gallons of water.

Koch's Herb Extract. Macerate:

Lemon peel	4½ ounces.
Calamus	2¼ "
Cinnamon	2¼ "
White ginger	2¼ "
Peruvian bark	2¼ "
Orris root	2¼ "
Juniper berries	4½ "
Bay leaves	2¼ "
Cubebs	2¼ "
Orange peel	2¼ "
Roman camomile	1⅛ "
Elder flowers	1⅛ "

in 2¼ gallons of rectified spirit of 90 per cent. Tr. Then press out and filter the fluid.

Maraschino. Compound 1 pound of maraschino essence with 4½ gallons of rectified spirit of 90 per cent. Tr. and 9 gallons of water; sweeten the mixture with a solution of 44 pounds of sugar, and filter.

Mogador. Dissolve 40 drops each of oil of wormwood, oil of calamus, oil of peppermint, and oil of orange peel, and 20 drops each of oil of cinnamon, oil of cloves, oil of ginger, and oil of balm in 1¾ gallons rectified spirit of 90 per cent. Tr.; sweeten the solution with 6 pounds of sugar dissolved in 7 pints of water, color it red with bilberry juice, and filter.

Nectar. Dissolve 120 drops of oil of lemon, 80 of fennel oil, 40 each of oil of calamus, oil of cinnamon, oil of cardamon, and oil of orange blossoms in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 6½ pounds of sugar dissolved in 1½ gallons of water, color it blue, and filter.

Orange Peel Cordial. I. Dissolve 2 fluid drachms of oil of orange peel in 1¾ gallons of rectified spirit of 90 per cent. Tr.; add 6½ pounds of sugar in 1½ gallons of water, color the fluid yellow, and filter.

II. Comminute ½ pound of fresh orange peel, pour 1¾ gallons of rectified spirit of 90 per cent. Tr. over them; sweeten with 6½ pounds of sugar dissolved in 1½ gallons of water, and filter.

Parfait D'Amour. Dissolve 80 drops of oil of lemon, 40 of oil of cinnamon, 30 of oil of bergamot, 20 of oil of cloves, 16 of oil of nutmegs, and 10 each of oil of lavender blossoms and oil of rosemary in 2¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 8¾ pounds of sugar dissolved in 2¼ gallons of water, color the fluid pale red, and filter.

Peach Cordial. Cut 1 pound of peaches in slices, then pour 1¾ gallons of rectified spirit of 90 per cent. Tr. over them, and allow the mass to digest for 8 to 10 days. Then filter and mix the filtrate with 1½ gallons of good white wine and 7¾ pounds of sugar dissolved in 1¾ quarts of water.

Peppermint Cordial. Dissolve 2 fluid drachms of oil of peppermint in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 6½ pounds of sugar dissolved in 1½ gallons of water, and filter.

Or, Dissolve 2 fluid drachms of oil of peppermint and 1 fluid drachm of cognac essence in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 6½ pounds of sugar dissolved in 1½ gallons of water, and filter.

Polish Water. Comminute 6½ ounces of dried currants, 1 ounce each of anise seed, cinnamon, cloves, fennel seed, mint, rosemary, marjoram, and galanga. Pour 4 gallons of alcohol and 3 gallons of rose-water over them, and let the mass digest for 14 days. Then add 44 pounds of sugar syrup, and filter.

Polish Whiskey. Comminute ½ pound of large raisins, 1 ounce of licorice root, ¾ ounce each of cinnamon and carda-

mons, ¼ ounce each of cloves, galanga, gum ammoniac, anise seed, and coriander seed, and ⅛ ounce of saffron. Pour 1¾ quarts of whiskey over these ingredients, let the mass digest for a few days, then press the liquor out, filter it, and sweeten it to the taste with sugar dissolved in rose-water.

Quince Cordial (*Quittico*). Powder coarsely 2 ounces of cinnamon, ½ ounce of coriander seed, ½ ounce of white ginger, and ¼ ounce of nutmeg. Macerate these ingredients for 8 days in 1 pint of spirit of wine 85 per cent. strong, then strain and press out the liquid and add 7 pounds of fresh quince juice in which 6 pounds of white sugar have been dissolved, and add 3 quarts of spirit of wine 85 per cent. strong. Mix the mass thoroughly and filter through felt or blotting paper.

Rosemary Cordial. Dissolve 2 fluid drachms of oil of rosemary and 24 drops of oil of lemon in 1¼ pints of rectified spirit of 80 per cent. Tr.; sweeten the solution with 1 pound of sugar dissolved in 1½ gallons of water, and filter.

Rossolio de Turin. Comminute 1 pound of fresh rose leaves, ½ pound each of jasmine blossoms and orange blossoms, 1 ounce each of orris root and cinnamon, ¼ ounce each of cloves and vanilla. Pour 1¾ gallons of spirit of wine over these ingredients and let them macerate for 8 to 12 days, placing them in a warm place. Then pour off the fluid, press out the residue, sweeten the liquor with 7½ pounds of sugar, and let it stand for 3 to 4 weeks. Then pour off the clear liquor, filter the sediment, and color red with cochineal or cherry juice.

Rostopschin. Dissolve 1¼ fluid drachms of anise seed oil, ½ fluid drachm of oil of cardamons, 40 drops of oil of lemon, and 20 drops each of oil of cinnamon and oil of coriander seed in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 6½ pounds of sugar dissolved in 1½ gallons of water, and filter.

Scubac. Comminute 4¼ ounces of juniper berries, 2 ounces of coriander seed, 1 ounce each of saffron and cinnamon, ½ ounce each of angelica seed and anise seed, ¼ ounce each of mace and cloves, and the fresh peel of 4 lemons. Pour 2 gallons spirit of wine over these ingredients and let them macerate for 2 to 3 weeks. Then boil 1½ ounces of raisins or dates in 1¾ gallons of water, pour off the liquor, press out the residue, and sweeten with 6½ pounds of sugar, and add this to the liquor pressed out of the macerated mass. Let the whole stand for 3 or 4 weeks, then pour off the clear liquor and filter the sediment.

Soya Aqua Vitæ. Comminute 3 ounces of anise seed, 1 ounce each of coriander seed, elecampane root, nutmeg, and cloves, ½ ounce each of caraway seed and elderberry blossoms, ¼ ounce of Roman camomile, 4¼ ounces each of lemon peel and orange peel, and 1½ ounces of cinnamon. Macerate these ingredients in alcohol for 2 or 3 weeks, then distil them with 5½ gallons of rectified spirit, add the necessary quantity of sugar, and compound the distillate with 1¾ pints of rose-water and as much water as may be required.

Spanish Bitters. Dissolve 80 drops of oil of Crete marjoram (origan), 40 each of oil of bitter oranges and oil of wormwood, and 20 each of oil of angelica, oil of cardamon, oil of calamus, oil of marjoram, and oil of thyme in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 6½ pounds of sugar dissolved in 1½ gallons of water, color it brown, and filter.

Stettin Bitters. Macerate 1 pound of gentian root, 8¾ ounces of wormwood, 1 pound of cloves, 4½ ounces each of coriander seed, cinnamon, and orange peel, 2¼ ounces each of green oranges and quassia in 9¼ gallons of spirit of wine 40 per cent. strong. Pour off the fluid, strain the residue, add 11 pounds brown sugar, filter the liquor, and color it brown.

Stomach Bitters. I. Comminute 2 ounces each of calamus, anise seed, caraway seed, and fennel, 1½ ounces each

of ginger and cinnamon, ½ ounce of mace, 1 ounce of cloves, 4¾ ounces of lemon peel, 1 ounce each of galanga, zedoary, and cubebs, ½ ounce of pepper, ¾ ounce of sassafras bark, 1½ ounces each of rose leaves, myrrh, and lavender blossoms, and 2 ounces of orris root. Pour 2 gallons of whiskey and 1¾ pints of water over the ingredients, let them macerate for 8 days, then press them out, filter the liquor, and add some common salt and 4½ pounds of crushed sugar.

II. Comminute ½ ounce each of speedwell, mint, balm, wormwood, arum root, zedoary, calamus root, small pomegranates, caraway seed, and cinnamon. Pour over them 1¾ quarts of good whiskey and let them macerate for 14 days in a warm place, with frequent shaking in the meanwhile. Then press the liquor out, filter, and put it in bottles.

III. Dissolve 40 drops each of oil of orange peel, oil of wormwood, oil of mint, and oil of calamus, 20 drops each of oil of marjoram, oil of cinnamon, oil of cloves, and oil of cardamon, and 1¼ fluid drachms of cognac essence in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 6½ pounds of sugar dissolved in 1½ gallons of water, color the liquor brown, and filter.

IV. Dissolve 60 drops of oil of orange peel, 40 each of oil of calamus, oil of angelica, oil of cardamon, oil of wormwood, oil of ginger, and oil of marjoram, and 2 fluid drachms of cognac essence in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 5½ pounds of sugar dissolved in 1½ gallons of water, and filter.

V. *Vienna Stomach Bitters.* Dissolve 40 drops each of oil of balm, oil of orange peel, and oil of angelica, 24 drops each of oil of marjoram, oil of wormwood, oil of cinnamon, oil of coriander seed, and oil of mace, and ½ fluid ounce of cognac essence in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 7¾ pounds of sugar dissolved in 2½ quarts of water. Color red and filter.

Swiss Cordial. Dissolve 40 drops each of oil of wormwood, oil of calamus, and oil of peppermint, 24 drops each of oil of bitter oranges, oil of marjoram, oil of cinnamon, oil of cloves, and oil of cardamons in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 4½ pounds of sugar dissolved in 1½ gallons of water, color the fluid green, and filter.

Thiem's Bitters. 1 pound of peeled calamus root, 2¼ pounds of orange peel, ½ pound of galanga, ¾ pound of white cinnamon, 5¾ ounces of cardamons, 4¾ ounces each of cloves and allspice, 2¼ ounces each of anise seed and fennel, 5¾ ounces of nutmeg, 1 ounce of Roman camomile, and 2¼ ounces of elecampane root are digested in 17 gallons of spirit of wine 50 per cent. strong for 24 hours in a still, and then 8½ gallons of liquor are distilled off, 55 pounds of sugar are dissolved in the distillate, and a sufficient quantity of water is added to give a volume of 26½ gallons of liqueur 30 per cent. strong.

Tivoli Cordial. Dissolve 80 drops each of oil of coriander seed and oil of mace, and 40 drops each of oil of lemon, tincture of vanilla, oil of cinnamon, and tincture of orris root in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 5½ pounds of sugar dissolved in 1½ gallons of water, and color the cordial brown.

Trappistine. 3½ ounces each of wormwood and angelica root, 1¾ ounces each of myrtle leaves and calamus root, ¼ ounce of cloves, 3½ ounces of cardamons, 7 ounces of peppermint, 2½ ounces of common balm leaves, ½ ounce of cinnamon, and ½ ounce of nutmeg are macerated for 48 hours in 2¼ gallons of rectified spirit 85 per cent. strong; 2¼ gallons of water are then added and the macerated mass is distilled. One gallon of water is then added to the distillate, and this is compounded with a *cold* syrup of 17½ pounds of sugar in 1 gallon of water, and finally a sufficient quantity of water is added to give an entire

product of 5½ gallons. This liqueur is colored green.

Vanilla Cordial. Macerate 2¼ ounces of vanilla beans for a few days in 1⅓ gallons of rectified spirit and 3 gallons of water, and then distil the mass. Add 22 pounds of dissolved sugar to the distillate, color it with cochineal, and filter.

Véritable Extrait d'Absinthe. Five pounds of anise seed, a like quantity of fennel, 1½ pounds of elecampane root, 2 pounds of calamus, 2 ounces of wormwood, 2½ ounces of leaves and stalks of wild basil, 6½ ounces of bitter almonds, 2 ounces each of hyssop, mint, and gnaphalium flowers are comminuted and digested in 3 gallons of rectified spirit of 90 per cent. Tr. The macerated mass is then pressed out, the liquor filtered, and 2 gallons of rum are added, and the fluid sweetened with 5 pounds of brown sugar dissolved in 2½ gallons of water.

Vienna Bitters. Dissolve 40 drops each of oil of bitter oranges, oil of wormwood, and oil of Crete marjoram (origan), 32 of oil of calamus, 20 each of oil of peppermint, oil of marjoram, oil of anise seed, oil of thyme, and oil of cinnamon, 24 of oil of coriander seed, and 12 of oil of cloves in 2 gallons of rectified spirit of 90 per cent. Tr. Add 3 quarts of good red wine to the solution, sweeten it with 6½ pounds of sugar dissolved in 3½ quarts of water, color it red, and filter.

Wormwood Cordial. Dissolve 1¼ fluid drachms of oil of wormwood, 32 drops of oil of lemon, and 20 drops each of oil of cinnamon and oil of cardamon in 1¾ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with 5½ pounds of sugar dissolved in 1⅓ gallons of water, and filter.

VI. RATAFIAS. *Barbadoes Ratafia.* Dissolve 80 drops of oil of lemon, a like quantity of oil of bergamot, 40 each of oil of cinnamon, oil of cloves, and oil of mace, and 1¼ fluid drachms of vanilla tincture in 1¾ gallons of rectified spirit of 90 per cent. Tr., and add 11 pounds of sugar, dissolved in 1⅓ gallons of water.

Cocoa Ratafia. Seven pounds of roasted cocoa are digested for 14 days in 1 gallon of alcohol 35 per cent. strong. Sweeten the mixture with 18¾ pounds of sugar dissolved in 2½ quarts of water, filter and add 90 drops of vanilla tincture.

Citronat-Ratafia. Dissolve 2½ fluid drachms of oil of lemon and 1 fluid drachm each of oil of bergamot, vanilla tincture, and essence of roses in 2 gallons of rectified spirit of 90 per cent. Tr., and sweeten the solution with 13 pounds of sugar dissolved in 1½ gallons of water.

Claret Ratafia. Comminute 2 ounces each of anise seed, dill, fennel, and coriander seed, and 4¼ ounces of caraway seed; macerate these ingredients for 14 days in 2 gallons of whiskey 22 per cent. strong, then strain the macerated mass through a linen cloth; add 5½ pounds of sugar dissolved in ¾ pint of water, and filter.

English Bitters Ratafia. Dissolve 80 drops of oil of bitter almonds, a like quantity of oil of angelica, 40 of oil of marjoram, 32 of oil of balm, 20 each of oil of wormwood and oil of cardamons, 120 of cognac essence, and 80 of vanilla tincture in 1¾ gallons of rectified spirit of 90 per cent. Tr., and sweeten the solution with a syrup made of 10 pounds of sugar and 1⅓ gallons of water.

Fennel Ratafia. Dissolve 2 fluid drachms of fennel oil, ¾ fluid drachm of oil of coriander seed, a like quantity of oil of anise seed, and 1¼ fluid drachms of orange blossom essence in 1¾ gallons of rectified spirit of 90 per cent. Tr., and sweeten the solution with a syrup made of 10 pounds of sugar and 1⅓ gallons of water.

Ginger Ratafia. Comminute ½ pound of ginger and ¼ ounce of vanilla beans. Pour 1¾ gallons of rectified spirit of 90 per cent. Tr. over these ingredients, let them stand for some time, draw off the fluid, and sweeten it with a solution of

10 pounds of sugar in 1¼ gallons of water.

Ratafia Chinoise (*Chinese Liqueur*) Comminute 1½ pounds of green oranges and 5¼ ounces of fresh stems of angelica; pour 2¼ gallons of spirit of wine over these ingredients, and let them macerate for 10 to 15 days. Then press the macerated mass out, filter the liquid, and sweeten it with 9 pounds of sugar dissolved in 1 gallon of water.

Ratafia de Grenoble. Comminute 1 drachm of cinnamon, ¾ ounce of cloves, 8¼ ounces of peach leaves, and a like quantity of cherry stones. Pour 1 gallon of whiskey over these ingredients, and let them digest for 2 to 3 weeks, when they are distilled. Add to the distillate 1 gallon of cherry juice, in which 2¼ pounds of sugar have been dissolved.

Mulberry Ratafia. Pour 22 pounds of spirit of wine over 26¼ pounds of mulberries, 1 pound of orris root, the juice of 4 lemons and of 4 oranges, and the peel of these fruits. Let them macerate for 4 to 6 weeks, then filter and compound the filtrate with 6½ to 9 pounds of sugar syrup.

Orange Ratafia. Slice 20 oranges, pour 13¼ pounds of rectified spirit of 90 per cent. Tr. over them, and let them stand for 8 days. Then press out the fluid, filter it, and add a solution of 10 pounds of sugar in 1¼ gallons of water.

Apple Ratafia. 26½ pounds of apple juice, ½ ounce each of cloves and mace, 7¾ pounds of sugar, and 22 pounds of spirit of wine are allowed to digest for 4 to 6 weeks, then add some ambergris, filter, and color the fluid yellow.

Pear Ratafia. 26½ pounds of pear juice, ½ ounce each of mace and cloves, 7¾ pounds of sugar, and 22 pounds of spirit of wine. Treat in the same manner as apple ratafia.

Stomachic Ratafia. Comminute 8½ ounces of pomegranates, 1 ounce of calamus root, ½ ounce of cloves, 2 ounces of caraway seed, 1 ounce of cinnamon, and ¼ ounce of mace. Pour 1 gallon of spirit of wine over the ingredients, and allow them to digest for 16 or 20 days. Then pour off the liquid, and press out the residue. Pour 3 quarts of boiling water over 1 ounce of peppermint, drain off the fluid, dissolve in it 3¼ pounds of sugar, and add this to the above fluid. Then let it stand quietly for 3 or 4 weeks, when the clear fluid is poured off, and the sediment filtered.

Celery Ratafia. 4½ ounces of celery seed, 5 drachms of coriander seed, and 3 drachms of cardamons are comminuted and digested for 3 weeks in 2½ quarts of whiskey 24 per cent. strong, when they are distilled on a water bath. The distillate is sweetened with 2¼ pounds of sugar dissolved in 1½ pints of water.

Scotch Ratafia. Mix 5½ ounces of jujube berries, 2¼ ounces of saffron, 1½ ounces of dates, 1½ ounces of grapes, ¾ drachm of coriander seed, ¾ drachm of cinnamon, and pour ¾ gallon of whiskey of 24 per cent. over the mixture. After allowing it to digest for 14 days, pour off the fluid, and add to it the fluid pressed from the residue. Sweeten with 2¾ pounds of sugar dissolved in 1½ pints of water.

Vanilla Ratafia. Cut 1 ounce of vanilla beans in small pieces. Pour 13¼ pounds of rectified spirit of 90 per cent. Tr. over them, add ½ fluid drachm of oil of orange blossoms, let them stand for 8 days, then filter, add 11 pounds of sugar dissolved in 1¼ gallons of water, and color pale red.

Wormwood Ratafia. Dissolve 2 fluid drachms of oil of wormwood, 32 drops of oil of cinnamon, 20 drops each of oil of cloves and oil of cardamons in 1½ gallons of rectified spirit of 90 per cent. Tr.; sweeten the solution with a syrup of 8¾ pounds of sugar, add 1 gallon of water, and color green.

HOUSEHOLD AND RURAL ECONOMY

Champagne Powder. To convert any wine, at a moment's notice, into champagne, take 30 grains of dry, pulverized bicarbonate of sodium, 23 grains of dry, powdered tartaric acid, and 2 ounces of pulverized sugar. Put the powder into a strong champagne bottle containing the wine and cork immediately. Then turn the bottle up and the champagne will be ready in one minute.

Champagne Mixture. Add to 5 quarts of must wine 1 pound of white sugar and a little alcohol. One glass of this mixture will convert any young wine into champagne.

Currant Champagne. Boil pure currant juice to the consistency of syrup and preserve in well-corked bottles. When to be used add a cupful of this syrup to ½ gallon of French wine and stir the mixture thoroughly.

English Champagne. To 10 pounds of gooseberry juice add 5 quarts of water and allow it to stand for 3 days; then press out and add 3 pounds of sugar and let it stand for 5 or 6 weeks, with occasional skimming, and add a small quantity of brandy and fill into bottles.

Fruit Champagne. Peel and grate juicy pears and press out the juice, which pour into a cask and cover the bung-hole with a linen cloth, and let the cask stand in a moderately warm room. Fermentation will begin in a few days, when the scum must be carefully removed. When the scum ceases, fill the cask with clear fermented pear juice (which has been fermented in a closely-corked bottle) and allow the cask to rest for 5 or 6 weeks in a cellar. Put a faucet in the cask about 4 inches above the chime, and draw the wine off into bottles and secure their corks with wire covered with pitch or wax. In about 2 weeks the wine will be fit for use, closely resembling champagne. It improves with age.

FRUIT WINES. *Apple Wine (Cider). English Process.* Store the apples for 10 to 14 days in an open shed and carefully reject the rotten ones. Then macerate the sound apples, enclose the pulp in a hair cloth, and place under a press, from which the juice is conveyed into barrels. If the apples are pressed without the hair cloth the bung-holes of the barrels must be covered with a brick until spring. The juice is then racked off into other barrels and ½ pound of hops and some burnt sugar are added and the bung-holes closed. The wine will not be fit to drink before a year.

Apple Wine (Normandy Process). The apples are crushed and pressed in the usual manner and the juice conveyed into barrels; but instead of allowing fermentation to take its course the juice, as soon as fermentation has commenced, is poured into other barrels, and again into others as soon as fermentation recommences. This is generally done 3 times.

The scum and precipitation of the 3 fermentations are then placed in woollen bags and suspended over a vat. The very clear apple wine draining from them is added to the rest. This wine has a very agreeable taste and can be kept for a long time.

Apple Champagne (Champagne Cider). To a champagne bottle full of apple wine take 2 to 3 ounces of sugar, dissolve it in the wine, add as quickly as possible ¾ ounce of finely-powdered tartaric acid and 1 drachm of finely-powdered bicarbonate of sodium, cork the bottle, secure the cork with wire, and let it lie for 8 days, when the champagne cider is ready for use.

Birch Wine. Bore holes in birch trees in the spring before the leaves ap-

pear and insert tubes to drain off the sap or juice. Branches of elder bush are often used for tubes. Large trees can be tapped in several places without injury. If a sufficient quantity of juice is not obtained in 1 day, it should be kept in bottles hermetically closed by covering the cork with wax or pitch.

Boil the juice, after a sufficient quantity has been collected, and carefully remove the scum as it arises. Then add 4 pounds of sugar and the rind of 1 lemon to every gallon of juice, and boil for ½ hour longer, carefully removing the scum. When cold the juice is fermented by adding yeast spread upon toasted bread, and is then allowed to stand for 5 to 6 days, being stirred occasionally. Now take a clean barrel holding exactly the quantity of wine prepared, suspend in it a piece of ignited sulphur, close the bung until the sulphur is extinguished, and then bring the wine into the barrel. As long as fermentation continues the bung is placed loosely in the bung-hole. When fermentation ceases the bung is driven in tight and the barrel allowed to lie for 3 months, when the wine is drawn into bottles.

Blackberry Wine. Cover ripe blackberries with boiling water in an earthen or wooden vessel and, when cool enough to admit the hand, crush the blackberries; cover the vessel and allow it to stand until the berries are forced to the top, requiring generally 2 or 3 days. The clear juice is then drawn off into a similar vessel and 1 pound of sugar added to every 3 gallons of fluid, when the whole is thoroughly stirred together and allowed to stand for 8 to 10 days. The wine is then filtered through a bag into a capacious vessel. The next morning 4 ounces of isinglass, previously soaked for 12 hours, are slowly boiled in 1 pint of white wine. When all is dissolved the above quantity is added to every gallon of the wine, the whole allowed to boil up once, and then poured into a cask.

Cherry Wine. Free perfectly ripe cherries from the stems, crush, and press them through a hair sieve. Then add to every gallon of juice 2 pounds of sugar and place it in a vessel just large enough to be entirely filled with it. When fermentation has run its course and no noise can be detected in the barrel, drive in the bung and allow the barrel to lay for 3 months, and then fill the wine into bottles.

Currant Wine. To every gallon of currant juice add 1 pound of sugar. When the sugar is dissolved put the juice in a cask, which should be entirely filled with it. Put this in a cellar until fermentation has run its course, then fill it up with juice previously fermented and close the bunghole. The wine remains in this barrel for 6 months, when it is drawn off into another barrel or into bottles.

Another Receipt. A beverage resembling Madeira wine is obtained by using equal parts of gooseberry and currant juice, dissolving in it 1 pound of sugar for every gallon of juice, and allowing the whole to ferment. The clear wine is then drawn off into another barrel and 1 pint of French brandy added to every gallon of it, when the bunghole is closed as tight as possible and the barrel allowed to lie in a cellar for 5 to 6 months, when the wine is drawn off into bottles.

Damson Wine. Ten pounds of damsons, when quite ripe, are crushed and boiled in 1½ gallons of water. Then press out the juice, add 3 pounds of sugar, let it ferment in a barrel, and add, after a fortnight, a little good brandy to it, when it will be fit to fill in bottles.

Elderberry Wine. Remove the stems from 100 pounds of elderberries, crush and boil them; then add 50 pounds of sugar, 2 pounds of cream of tartar, and 35 gallons of water, and let the mixture ferment. By adding a little ginger, cloves, raisins, and yeast, it will yield at the termination of the fermentation a wine similar to Cyprus wine.

Ginger Wine. Add 20 pounds of sugar to 12 gallons of water and boil to a syrup. Then boil in a separate vessel 1 pound of white Jamaica ginger in 2½ gallons of water and add, while boiling, a few lemon peels. Then mix both liquids, add a little yeast and 4 pounds of seeded raisins. Let it ferment for several weeks, and then add 1 pound of tartaric acid and 2 gallons of elderberry juice.

Honey Wine. To 2 pounds of honey add 1 gallon of water. Boil the mixture for 1 hour, continually skimming it; then add some yeast and let the liquid ferment, hanging into the barrel a bag containing bruised spices, such as coriander seeds, cloves, ginger, and calamus, of each 1 ounce. The fermented liquor will be clear after 1 month, when it can be drawn into bottles.

Orange Wine. Boil 40 pounds of sugar for ½ hour with 13½ gallons of water. At the same time press out and filter the juice of 75 oranges and mix it, together with the rinds, with the sugary fluid after the latter has been cooled off to about 85° F. The mixture is then poured into a cask and frequently stirred during 3 or 4 days, when the cask is bunged and placed in a cellar for 6 months, when the wine is drawn off.

Orange Wine with Lemon. Dissolve 6½ pounds of sugar in 1½ gallons of water at a temperature about 105° F. Add to this the juice of 5 good lemons and 3 table-spoonfuls of beer yeast, and let the mixture ferment for 48 hours. In the meanwhile grate the rinds of the lemons and those of 25 oranges upon 1 pound of loaf sugar, add this to the fermenting liquid and immediately afterwards the juice of the 25 oranges, and then let the whole ferment for 48 hours longer. Then pour the fluid into a cask, add 1 pint of wine, bung the cask, and let it lie for 6 months, when the wine can be drawn off into bottles.

Raisin Wine. To 6½ pounds of raisins add 20 pounds of water, 2 pounds of sugar, 8¾ ounces of cream of tartar, and sufficient yeast to bring the mass into fermentation. If the wine is to be consumed at once it is not necessary to add yeast.

Another Receipt. Pour 30 gallons of ordinary wine over 20 pounds of raisins previously picked over, freed from stems and stoned, and stir the mass thoroughly. Next prepare a solution of 8¾ pounds of fine loaf sugar in 1 gallon of water by boiling, and when this is cold add it to the raisins and wine; then add a saturated solution of ¼ ounce of bicarbonate of potassium and immediately afterwards a solution of ¼ ounce of tartaric acid in a little water. Bung the cask loosely, shake it thoroughly, place it in a moderately warm place, and then remove the bung. After 4 weeks add 4½ pounds of loaf sugar and a like quantity after 6 weeks. Fermentation will cease in 8 to 10 weeks. The wine can then be fined with gelatine, isinglass, or white of egg, and drawn off into bottles. It has an agreeable taste resembling very much that of Spanish wine.

Raspberry Wine. Crush the berries with a spoon and filter the juice through flannel into an earthen pot. To each quart of the juice add 1 pound of fine sugar, stir the mass thoroughly, and let it stand for 3 days. Then pour off the clear fluid, add to every quart of juice 2½ gallons of white wine, and fill the liquor in bottles. The wine can be used in 6 to 8 days.

Ginger Beer. To 3 gallons of water add 4½ ounces of bruised ginger root, 2 ounces of cream of tartar, and 4½ pounds of sugar. Boil for a few minutes, and after cooling add about 1 table-spoonful of fresh yeast. Cover up the vessel with a thick flannel cloth and let it stand over night. Then add a little essence of lemon, strain it, put the fluid in clean bottles, and secure the corks with twine or wire. The beer will be fit to drink after standing 4 days.

English Ginger Beer. Boil 3 ounces of pulverized ginger, 2 ounces of cream

of tartar, and 2 pounds of sugar with $1\frac{1}{2}$ gallons of water. When cold add a table-spoonful of yeast to the fluid, let it stand over night, then filter, and draw into bottles which should be well corked.

Spruce Beer. Put into a common soda bottle about 30 grains of bicarbonate of sodium, 10 drops of essence of spruce, and about 30 grains of crystallized tartaric acid. Fill the bottle quickly with spring water, cork, and secure the cork with twine or wire.

Another Receipt. Comminute the young sprouts of the spruce tree, then boil them with water until they turn yellow and the bark peels off easily. Add some toasted bread and malt, let the fluid ferment in the ordinary manner, and bottle. The proportions of the materials used are as follows: Ten gallons of water, $1\frac{3}{4}$ quarts of young spruce sprouts, $\frac{1}{4}$ pint of syrup (or, instead of the syrup, 1 pint of malt or $\frac{3}{4}$ pint of carrots), and some toasted bread and yeast.

English Spruce Beer. Comminute the young spruce sprouts, press out the juice, and boil it down to the consistency of syrup. Put the syrup in well-closed bottles, where in the course of time it will lose all taste of resin. When it is to be used dilute the necessary quantity with water and ferment with yeast.

From the Archives

From The Archives

Here is a selection from 19th Century Harper's Monthlies. They are various entries in the science sections which are thought provoking and sometimes clever. There might be an idea here, dropped back then, but worthy of reconsideration.

EXTINCTION OF THE TASMANIAN RACE.

The extinction of a star in the heavens has at various times excited the interest of astronomers. To the philanthropist the destruction of an entire race should be a matter of much greater moment. We are informed that the last male Tasmanian has recently departed this life, and that the sole survivor of the aboriginal inhabitants of the island is an aged female.

CARBOLIC ACID AND CHOLERA.

A Paris journal contains a letter from a correspondent in Nicaragua, detailing the effect of the use of carbolic acid as a preventive of disease during the cholera epidemic in that country. The superintendent of an extensive plantation, employing several hundred persons, took the precaution to water the corridors and interior of the buildings every day with a solution of the acid, and had the pleasure of finding, as the result, that not a single member of his establishment died of the disease, although many fatal cases were constantly occurring in the neighborhood. An additional advantage was the disappearance of intermittent fever, as well as of fleas, bugs, and other vermin. It was also used with entire success in driving away ants, which are so troublesome as neighbors in tropical countries.

REMEDY FOR WHITE ANTS.

The ravages of the white ants in tropical countries are familiarly told of in works of travelers, and given as among the most remarkable curiosities of insect life; and much ingenuity has been expended in the attempt to eradicate or destroy them. It is said by a late writer that by scattering common salt around places frequented by them they will soon be made to disappear entirely.

GUN-COTTON IN BISULPHIDE OF CARBON.

According to Dr. Bleekrode, if gun-cotton be first wet with bisulphide of carbon (a highly inflammable liquid), and an electric spark be passed through it, instead of producing an explosion of the cotton, the bisulphide alone is set fire to, the gun-cotton apparently remaining intact among the burning bisulphide, presenting almost the aspect of a mass of snow slowly melting away. The experiment may be varied by using either benzine or alcohol instead of the bisulphide, and igniting it afterward with any flame. All these liquids yield the same result, and there is no danger in the experiment, even if large quantities are used. This curious phenomenon is explained by Dr. Abel, who says that "these results indicate that if, even for the briefest space of time, the gases resulting from the first action of heat on gun-cotton upon its ignition in open air are impeded from completely enveloping the burning extremity of the gun-cotton twist, their ignition is prevented; and as it is the comparatively high temperature produced by their combustion which effects the rapid and more complete combustion of the gun-cotton, the momentary extinction of the gases, and the continuous abstraction of heat by them as they escape from the point of combustion, render it impossible for the gun-cotton to continue to burn otherwise than in the slow and imperfect manner, undergoing a transformation similar in character to destructive distillation."

As a practical application of these facts, it is suggested that if gun-cotton be kept in a flask in a layer of benzine or bisulphide of carbon, the danger of explosion in case of a fire is obviated, since, if the liquid is ignited by any means, the gun-cotton will burn slowly and gradually. When required for use, a brief exposure to the air restores its explosive qualities.

EXTRACTION OF PEPSIN BY GLYCERINE.

Among the many applications of glycerine, not the least important is that which has recently been made of it in the extraction of pepsin and other ferments found in animal and vegetable bodies. If the mucous membrane of a pig's stomach be well washed, and, after the removal of the water, be reduced to fine shreds and bruised, and the whole be then covered with pure glycerine, this will be found, after standing twenty-four hours, to have extracted the pepsin in an appreciable quantity so as to readily digest fibrine. The operation may be repeated several times successively with a similar result.

On treating these glycerine extracts, after filtering, with a large excess of alcohol, a precipitate is obtained, which, separated by filtration, and being redissolved in acidulated water, has strong peptic qualities, with very slight proteid reaction. Mr. Foster, in calling attention to this method in *Nature*, dwells upon the importance of glycerine in this and similar applications in working out the problems of the so-called ferments, as these glycerine extracts seem to remain unchanged for a long period, thus allowing a stock of ferment to be continually kept on

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LIQUORS AND BEVERAGES

Beer Brewing. The fabrication of beer is divided into three principal operations: 1. Fabrication of malt. 2. Preparation of the liquor containing the dextrine and sugar; and 3, the fermenting of this liquor.

1. *Fabrication of Malt* requires 3 operations: *a*, Steeping; *b*, Germinating (Couching); *c*, Kiln-drying.

a. Steeping. The barley is first uniformly moistened in the steeping-vat, and then covered with water 4 to 6 inches deep. The light grains floating on top are removed. During this operation carbonic acid is evolved, the water acquiring a yellowish color, while the barley absorbs water equal to about ½ of its volume, the increase in weight being more than ½. After 24 hours the water is drawn off and replaced by fresh, this being repeated 3 or 4 times according to the temperature of the air. The operation is finished if the grains can be crushed between the fingers without exuding in the form of a milky juice. In steeping, strict attention must be paid to avoid acid fermentation.

b. Germinating (Couching). The water being drawn off the barley is allowed to drain off and laid upon the couch floor of stone flags in heaps 5 to 8 inches high, and turned every 5 or 6 hours to insure an even temperature and uniform germination. The temperature of the heap should never be allowed to rise above 60° F. When germination begins the heap is piled up from 7 to 14 inches high. The temperature rises from 77° to 80° F., and the barley commences to sweat, which may be recognized, if, on thrusting the hand into the heap, it not only feels warm but gets bedewed with moisture. The radicles and acrospire begin to develop. The latter issues from the same end of the grain as the radicle, but turns over and proceeds within the husk towards the other end, and would there come forth as a green leaf were its progress not arrested. The malting, however, is complete before the acrospire becomes a leaf. As soon as the radicles and acrospire begin to grow, the barley, to admit air and check too rapid development, is spread thinner upon the floor, and turned over several times in the course of the day. As soon as the radicles have become 1½ longer than the barley, and are contorted so that the grains hook into one another, and the acrospire is just beginning to push through, the barley is spread very thin on the floor, and when it feels no longer moist, brought into the kiln.

Kiln-drying expels the moisture from the germinated grains and converts the starch into dextrine and glucose, and stops the progress of germination and renders the mass fit for storage. The kiln is a chamber with a perforated iron or copper bottom to allow the heated air to permeate through the malt, which is spread upon the bottom about 3 to 4 inches deep. The temperature must not be too high at first, and is gradually increased to, but must never rise above, 158° F. During the kiln-drying the roots and acrospire of the barley become brittle and fall off, and are separated by a wire sieve. The barley, by germinating and kiln-drying, loses 8 per cent. of its weight.

2. *Preparation of the Liquor containing the Dextrine and Sugar (Mashing).* The object of this operation is to extract from the malt the sugar and dextrine by means of water, and to convert the starch into the same substances by the diastase. The beer, be-

sides alcohol, must contain dextrine, and the action of the diastase must therefore be arrested before the dextrine is entirely converted into sugar, this being accomplished by boiling the watery solution. The operations necessary for gaining beer from the malt are: *a*, the actual mashing, or preparation of the wort; *b*, boiling the wort with hops: and *c*, cooling the boiled wort.

a. Mashing. The malt is coarsely ground in a grain-mill and mixed with water in a vat, and after 4 to 6 hours immersion, hot water is added to raise the temperature to 168° F., the vat covered, and the mash allowed to stand for 1 to 2 hours, when the clear wort (*wort-black*) is drawn off into a covered vessel and the residue washed several times with water.

b. Boiling the Wort with Hops. The clear wort is boiled in the copper together with the hops. The albumen and unchanged starch are precipitated by the tannin of the hops, and a bitter taste imparted to the beer and its durability augmented. After boiling for several hours the wort, to prevent acid fermentation, must be immediately cooled.

c. Cooling. In small breweries the beer is run into coolers, but in larger establishments refrigerators of various constructions are employed. The cooler is a large shallow vessel constructed of planks. It must be so placed that the wort can be cooled as quickly as possible to 60° to 68° F. In bringing the wort in the cooler the exhausted hops are retained by the hop-strainer.

d. Fermentation. When the wort is sufficiently cooled it is conveyed into the fermenting vat. Six or 8 hours after the yeast has been added fermentation becomes active. The temperature of the fermenting cellar should not rise above 59° F. A thin white froth appears first on the middle, and spreads gradually over the whole surface, whose color gradually changes into a yellowish-brown by the action of the air. Fermentation is finished in 5 to 8 days, according to the temperature of the cellar. After the beer is clear it is drawn off into barrels in the store-cellar for after-fermentation.

Improved Process of Brewing. The malt is mashed with water at 140 to 158° F. in a vat hermetically closed and provided with a stirring apparatus, double bottom, man-hole, etc., whereby the mash acquires a temperature of 120° F., which is raised to 167° F. by introducing steam at 257° F. between the 2 bottoms of the mash tun. The clear mash is then forced by steam from the grains into the clear mash-back standing higher than the mash tun. To dissolve the peptones, etc., the grains are steamed and then cooled off to 167° to 178° F. by squirting cold water over them, and the clear mash is then brought back into the mash tun in order to undergo a second complete saccharization. The mash is then heated to 212° F., and, after resting, forced into the hop-back.

New Brewing Process. The mash is thoroughly worked for 5 minutes in water at 120° F., and allowed to stand for 10 minutes. The supernatant liquor is then brought into the clarifying tun, and to every 25 gallons are added 1 pound of scalded hops and ½ ounce of carbonate of lime. The thick mash remaining in the copper is first heated to 145° F., and then to 170° F., and after saccharization is complete, boiled for 1 hour with an addition of 2¾ ounces of carbonate of lime to every 2000 gallons of mash; the liquor first drawn off from the thick mash is then added. After standing for ¼ hour the wort is pumped into the pan and boiled for 2 hours. The hops, previously boiled alone for 2 hours and cooled off to 190° F., are then added to the mash, cooled to the same temperature. The wort is then pumped into the cooler, where 2 to 2¾ ounces of carbonate of lime are added

to every 2000 gallons.

To prevent fermentation and putrefaction of the albumen, ½ ounce of magnesia are added to every quart of the setting yeast.

Clarifying Beer. A very concentrated solution of phosphate of soda is first put into the wort, and then gypsum or chloride of calcium and slaked lime are added. Instead of the soda salt, phosphoric acid or some soluble phosphate of lime may be employed. This clarifier can be used at any stage of the process, either before or after fermentation. The same process is also recommended for other fermented liquors.

Flaxseed Pulp for Clarifying Beer. For every 60 gallons of beer boil ¾ pint of washed flaxseed in 1 gallon of water, replacing the water lost by evaporation by fresh. Separate the pulpy liquid from the seeds by straining and add it to the brewing ½ hour before mixing the hops with it. When the latter is added the flaxseed pulp coagulates, enclosing the substances which make the beer turbid and settling with them on the bottom of the boiler. Beer prepared in this way becomes clear in a very short time, its taste being not injured in any respect.

Brewer's Pitch. Light Yellow Pitch. Melt in an open iron boiler 100 pounds of pine pitch, and then add, with constant stirring, 5 to 6 pounds of caustic soda-lye of 10° B. When the mass in the boiler no longer rises, and the formation of bubbles has ceased, the fatty pitch is poured into iron moulds and allowed to cool.

Brown Pitch. I. Melt in an open iron boiler 150 pounds of pine pitch and 50 pounds of red, transparent American rosin; then add 10 pounds of rectified heavy rosin oil, stir thoroughly, and pour into moulds.

II. Composed of pine pitch 100 pounds, red, transparent rosin 85 pounds, and rectified heavy rosin oil 10 pounds.

III. Seventy-five pounds of pine pitch, 140 pounds of red, transparent rosin, and 12 pounds of rectified heavy rosin oil.

IV. Pine pitch 50 pounds, red, transparent rosin 150 pounds, and rectified heavy rosin oil 10 pounds.

V. Pine pitch 40 pounds, brown rosin 160 pounds, and rectified heavy rosin oil 10 pounds.

Ordinary Brown Brewer's Pitch. Melt in an open iron boiler pine pitch 30 pounds, brown rosin 175 pounds, and rectified heavy rosin oil 10 pounds.

Hop Pitch. Melt good brewer's pitch for ½ hour with 5 per cent. of hops, pass the mixture through a fine wire cloth, and finally add 0.01 per cent. of oil of hops. This pitch, it is claimed, contributes to make the beer durable and aromatic.

Glaze for Beer Barrels. Glazing beer barrels, being cheaper and better than pitching, is adopted in many large breweries. For this purpose dissolve ½ pound of rosin, ⅛ pound of shellac, 1/16 pound of turpentine, and 1/16 pound of yellow wax in 1 quart of strong spirit of wine, and apply the solution twice to the inside of the barrel by means of a brush. As soon as the second coat is dry, apply one prepared by dissolving 1 pound of shellac in 1 quart of strong spirit of wine. This varnish closes the pores, does not break off nor injure the taste of the beer.

Prof. Artemus recommends to coat the inside of the barrel with a solution of soda water-glass of 1.25 specific gravity rubbed up with ½ of 1 per cent. of magnesia. This glaze is very cheap and, as it can only be dissolved by long continued boiling in water, allows of a thorough cleansing of the barrels.

Testing Beer for Foreign Bitter Substances. Heat about 2 quarts of the beer, to be examined over a water-bath until the largest part of the carbonic acid and about ¼ of the water are evaporated. To precipitate the bitter substances derived from the hops, compound the fluid, *while still hot*, with basic acetate of lead as long as a pre-

cipitate is formed. The richer the lead salt is in plumbic oxide the more readily will the hop constituents be removed. Filter off the precipitate of lead *as quickly as possible*, protecting it at the same time from the action of atmospheric carbonic acid, which would decompose it. Washing out the precipitate is not advisable. The excess of lead added in the filtered fluid is precipitated with the necessary quantity of sulphuric acid; a quick settling of the sulphate of lead is accomplished by an addition of about 40 drops of a solution of 1 part of gelatine in 20 of water before adding the sulphuric acid. The fluid, after it is again filtered, must, if the beer was unadulterated, have no bitter taste if a few drops of it are placed upon the tongue.

Now compound the fluid with sufficient ammoniacal liquor to neutralize all the sulphuric acid and a part of the acetic acid. Then evaporate it in the water-bath to ½ pint. To precipitate the dextrine, etc., mix the residue with 4 parts by volume of absolute alcohol, shake the mixture thoroughly, then place it in the cellar for 24 hours, and finally filter it. After distilling off the largest part of the alcohol, mix the aqueous residue of distillation, now reacting acid, successively with *petroleum-ether, benzole*, and *chloroform*. Then add ammonia to the aqueous fluid until it shows a perceptible alkaline reaction, and then repeat the shaking with the three fluids in the order given.

Pure Beer prepared from malt and hops shows, if treated in this manner, the following action:

*Acid Mixtures. Petroleum-ether.** The solid part obtained by evaporating the residue of the mixture with petroleum-ether has scarcely any bitter taste, and when dissolved in concentrated sulphuric acid †, in sulphuric acid and sugar, or in nitric acid, gives a very slightly yellowish-colored solution, and in concentrated hydrochloric acid almost a colorless one.

Benzole ‡ withdraws only very small quantities of a resinous substance, which acts towards the mentioned acids in a similar manner as that isolated by the petroleum-ether. This substance has also only a slightly bitter taste.

Chloroform acts similar to benzole.

Ammoniacal Shakings. § *Petroleum-ether* absorbs next to nothing.

Benzole withdraws only traces of a substance giving no characteristic reaction of color.

Beer Wort acts in the same manner as fermented beer.

By the same method the addition to the beer of the following 13 substitutes for hops can be shown.

1. *Wormwood.* On shaking the acid fluid with petroleum-ether, ethereal oil is found, which is recognized by its odor and a part of the bitter substance. The residue of evaporation gives a brown solution in concentrated sulphuric acid, which, on being allowed to stand in the moist air of a room, assumes a violet color. Compounded with sulphuric acid and a little sugar it acquires gradually a red-violet color. By dissolving a part of the evaporated residue in a little water the filtered solution reduces ammoniacal solution of silver, while precipitates are obtained with chloride of gold and potassium mercuric iodide, but only slight turbidity with tannin, potassium bromide, potassium iodide, and mercurious nitrate.

Benzole and *Chloroform* absorb also the bitter substance which reacts as described above.

2. *Marsh Rosemary* (*Sedum palustre*). In the extract with petroleum-ether some ethereal oil having the characteristic odor of marsh rosemary is found. The small residue treated with concen-

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* Should boil between 91.4° and 140° F.

† The sulphuric acid should be as free as possible from nitric acid.

‡ Benzole boiling at 176° to 177.8° F., and previously rectified, must be used.

§ Before making the fluid alkaline it must be once more mixed with petroleum-ether, in order to remove all traces of chloroform.

trated sulphuric acid acquires a more brownish color than ordinary beer, but for the rest does not remarkably differ from it.

Benzole and *Chloroform* absorb amorphous substances of a bitter taste, which give dark red-violet solutions with sulphuric acid and sugar, and, on being boiled in dilute sulphuric acid (1.10), develops an odor of *ericinol*. The solution reduces chloride of gold and alkaline solution of copper, while a precipitate is obtained with potassium iodide and tannin, but not with basic lead acetate. Benzole also absorbs small quantities of a substance which reduces ammoniacal solution of silver. Chloroform absorbs a substance which is precipitated with potassium-mercuric iodide.

3. *Bog Bean, Marsh Trefoil* (*Menyanthes trifoliata*). In the extract with petroleum-ether only traces of the bitter substance are found. *Benzole* and *chloroform* absorb more of the bitter substance (*menyanthin*), the taste of which can be detected in the evaporated residue. The latter, on being heated with dilute sulphuric acid (1.10), develops also the characteristic odor of *menyanthol*, reduces ammoniacal solution of silver, and is precipitated or, at least, made turbid with potassium-mercuric iodide, potassium iodide, tannin, and chloride of gold.

Nothing characteristic is found on shaking with ammoniacal liquor.

4. *Quassia*. Petroleum-ether absorbs but very small traces of the exceedingly bitter quassiin, which does not differ by any other reaction from substances obtained from pure beer. Larger quantities of quassiin are isolated by benzole and especially by chloroform. When treated with sulphuric acid and sugar it acquires a pale reddish color, reduces slightly ammoniacal solution of silver and chloride of gold, and precipitates potassium-mercuric iodide, potassium iodide, tannin, and basic lead acetate.

5. *Colchicum Seeds*. Petroleum-ether yields substances similar to those isolated from unadulterated beer. *Benzole* absorbs small quantities of *colchicin* and *colchicein*, which taste bitter and give a yellow solution with concentrated sulphuric acid, which, on saltpetre being added, acquires a violet, blue, and later on a green color. The last reaction of color being also obtained with nitric acid of 1.30 specific gravity. By adding to the solution in nitric acid, when it has ceased to throw up bubbles, caustic potash, until a strong alkaline reaction takes place, a very durable cherry to dark-red coloring is obtained. *The chloroform residue* yields larger quantities of the above constituents of the meadow saffron, so that, besides the above-mentioned color reactions, precipitates are obtained with the alkaloid reagents commonly used.

6. *Indian Berries* (*Cocculi Indici*), *Petroleum-ether*, and *Benzole* absorb from the beer adulterated with Persian berries only such constituents as from pure beer. With *chloroform* and, still easier, with *amyl alcohol* the picro toxin is withdrawn from the fluid, but, on evaporating, it remains behind generally in such an impure state that it cannot be directly used for color reactions. It is therefore best to test whether a part of the residue reduces an alkaline solution of copper, and another part, dissolved in water, has a poisonous effect upon fishes. In this case, re-dissolve the remainder of the residue in warm water, shake again with chloroform, and repeat this until the residue of the chloroform shakings appears crystalline, after having been allowed to evaporate spontaneously in the ordinary temperature of a room. On re-dissolving the residue in alcohol, and allowing it to evaporate slowly, large needle-like crystals should remain behind, which give a yellow solution in concentrated sulphuric acid. By mixing this solution intimately with 5 to 6 parts by weight of pulverized saltpetre, then moistening it with sufficient pure, concentrated sulphuric acid to form a plastic mass, and finally adding soda-

lye of 1.3 specific gravity until a strong alkaline reaction takes place, a brick-red fluid is obtained.

7. *Colocynths.* The *colocynthin* does not pass into *petroleum ether* and *benzole*, but is shaken out with *chloroform.* It is extremely bitter, is precipitated from an aqueous solution with tannin, reduces alkaline solution of copper, and dissolved in sulphuric acid gives a red solution, and in *Fröhde's* reagent* a violet one. But the latter reactions succeed only after the colocynthin has been purified by repeated dissolutions in water and shaking with chloroform.

8. *Willow Bark.* The *salicin* found in the young bark of several species of willow and poplar cannot be well obtained from acid extracts with *petroleum-ether*, *benzole*, and *chloroform*, but easily so with amyl alcohol. On heating the salicin with potassium bichromate and dilute sulphuric acid (1.4), it emits the odor of *salicylic acid.* In concentrated sulphuric acid it gives a red solution, and in *Fröhde's* reagent a violet-red one; but both reactions succeed only when the salicin is very pure, which is difficult to obtain even by repeated dissolutions in water and shaking the filtered solutions with amyl alcohol.

9. *Strychnine* cannot be gained from the acid solution, but only from the ammoniacal fluid, and then only in small quantities with *petroleum-ether*, and somewhat less difficult with *benzole* and *chloroform.* To establish the alkaloid it is best to use its well-known reaction upon sulphuric acid and potassium bichromate.

10. *Atropin* and

11. *Hyoscyamin* are also obtained by shaking the ammoniacal solution with *benzole* and *chloroform.* They are precipitated with most reagents upon alkaloids, but, as good color reactions are wanting, must be confirmed by physiological tests.

The process is modified for proving.

12. *Aloes.* By treating the beer, in preparing it for the test, only with *neutral* lead acetate, and shaking it later on with amyl alcohol. After evaporation a residue with the characteristic taste of aloes must remain, and which yields precipitates with potassium bromide, basic lead acetate, and mercurious nitrate, and, being heated, reduces alkaline solution of copper and solution of gold. Tannin must also precipitate it, but, on being added in excess, partly redissolves the precipitate. By boiling a part of the residue with concentrated nitric acid, and expelling the latter over a water-bath, a mass remains which, on being heated with caustic potash and potassium cyanide, acquires a blood-red color.

13. *Gentian Root.* The beer is also prepared for this test by treating it with neutral lead acetate, filtering and removing the excess of lead, with just the necessary quantity of sulphuric acid. The fluid is then evaporated to the consistency of syrup, and this acidulated with nitric acid, and then subjected to the process of dialysis. The neutralized dialysate is again precipitated with neutral lead acetate, then filtered, and the filtrate compounded with basic lead acetate, whereby the bitter principle of gentian root (*gentianin*) is precipitated. The precipitate, after filtering and washing, is decomposed with sulphide of hydrogen, and the filtered fluid shaken with *benzole* or *chloroform.* By adding ferric chloride to an aqueous solution of gentianin it will be colored brown, but is not precipitated by it. Gentianin reduces ammoniacal solution of silver and alkaline solution of copper. It is precipitated with potassium bromide and mercurious nitrate, chloride of gold, and phosphomolybdic acid, while corrosive sublimate and potassium-mercuric iodide cause turbidity.

Determination of Glycerine in Beer. For Dark Beers. Evaporate carefully

*0.15 grains of sodium molybdate dissolved in 40 drops of pure concentrated sulphuric acid.

in a water-bath, at about 165° F., 6 fluid ounces of beer and 1½ drachms of magnesium hydrate. Rub the residue before it is entirely dry with 3 fluid ounces of absolute alcohol, then filter off the alcohol and wash the residue with 3 fluid ounces of alcohol. Then compound the filtrate with 3½ times its volume of absolute ether in order to separate the maltose and parapepton, and then allow the filtrate to stand for 12 hours for the volatilization of the ether. Place the remaining alcoholic solution in a flask previously weighed, evaporate it to a syrup on the water-bath, and dry it in a rarefied space for 12 to 24 hours. Extract the residue with about 1 fluid ounce of absolute alcohol, free the fluid by filtering from the separated cholesterin, malt fat, etc., wash it with ½ fluid ounce of absolute alcohol, and evaporate the filtrate over the water-bath, then dry it under the air-pump and weigh it as glycerine.

For Light Beers, poor in peptones, take up the mass thickened with magnesium hydrate with absolute alcohol, filter, evaporate the filtrate to a syrup, dry it under the air-pump, add a mixture of 1 part of absolute alcohol and 1 part of ether, stir vigorously with a glass rod, filter through a very small filter, wash with the same mixture, evaporate carefully, and finish the process under the air-pump.

Alcohol and Compressed Yeast from uncrushed Cereals without the Use of Steam Pressure. Acidulate 50 gallons of water with 2 ounces of pure sulphuric acid of 66 per cent., and in it soak 20 pounds of the cereals without being crushed, at a temperature of about 104° F. After soaking for 48 to 60 hours the material is brought together with the water into the preparatory mashing tun, which is provided with a mashing machine, and saccharization takes place at 140° F.

To Convert Alcohol of 70 per cent. into 90 per cent. in the Cold Way. Mix calcined potash with alcohol of 70 per cent. until the phlegm, when shaken, shows 80 per cent.; then pour the alcohol carefully into another vessel, and add potash until it shows 90 per cent. Then pour it into a third vessel, and to cleanse it, which will require about 1 hour, add some more potash, and some burnt alum. The potash before using it, must be pulverized, sifted, and calcined in an iron vessel.

To Purify Alcohol obtained from Beets and Molasses. The alcohol is brought into a vessel of galvanized iron or enamelled wrought iron. For every 20 gallons of alcohol of about 90 per cent., 2 to 2½ ounces of caustic potash are added. The mixture is allowed to stand quietly for about 1 hour, when it is thoroughly stirred and the agitation repeated every 12 hours during the first 24 hours. After standing quietly for 12 hours, 10 per cent. of water is added, and the agitation repeated every 12 hours during the next 36 hours. It is then allowed to rest for 24 hours, and filtered through a layer of asbestos. The potash is next neutralized with tartaric acid. After stirring it and then resting for 12 hours about 2 gallons of water are added to every 20 gallons of alcohol. The liquid is again allowed to rest for 12 hours, and filtered before rectifying.

To Purify Alcohol. The process consists in adding a small quantity of nitrate of silver to the crude alcohol, ¾ to 1¾ ounces being required for 2000 gallons of crude alcohol, according to quality and strength. For practical use it is best to prepare a solution of 10 parts of nitrate of silver in 100 of water. After the alcohol has been mixed with the solution it is converted into high-proof spirits. Rectified spirit produced by this process is destitute of all bad odors to a degree not otherwise attainable. The invention is available with equal success for any kind of spirit of wine; an addition of but 7 grains of nitrate of silver to 100 gallons of spirit of wine being sufficient to remove the bad odors from the poorest quality coming into

commerce. For practical use it is best in these cases also to prepare solutions of nitrate of silver in water, namely, for the first, 1 part of nitrate of silver to 100 of water, and for the last, 1 part of nitrate of silver to 1000 of water.

To Prepare Absolute Alcohol. The easiest way of accomplishing this is to pour strong alcohol over anhydrous sulphate of copper, and agitate as long as the salt is colored blue, and then distil the fluid.

Manufacture of Cog· :. The process in the *Cognac* district is as follows: The wine to be distilled is first brought into a stone trough, and is then pumped into a bronze boiler called the "chauffe-vin," whence it can flow into a still. In the chauffe-vin and in the retort the wine is heated by a coal fire, at first strongly and then gradually weak. After a short time a white, generally transparent, liquor called "*broullis*," which should amount to about ⅛ of the quantity of wine brought into the chauffe-vin, begins to run from the mouth of the cooling-pipe. The brown fluid, containing but very little alcohol, which remains in the retort is emptied and thrown away. Fresh wine is then conveyed into the chauffe-vin, and the distillation commences anew, and is continued day and night until all the wine has been converted into spirits, which is finally rectified.

Artificial Cognac. The following compound, after storing for some time, will closely resemble the genuine article in taste and aroma: I. Mix 10 ounces of acetic acid, 7 ounces of *spiritus nitricoætherens*, 1¾ gallons of white French wine, ¾ pint of tincture of oak bark (extracted from 4 ounces of oak bark), and 30 gallons of spirit of wine of 55 to 60 per cent., and the requisite quantity of sugar color.

II. *Artificial Cognac of a very fine flavor* is obtained by mixing 2400 parts of alcohol of 90 per cent., 1600 of water, 8 of *spiritus nitricoætherens*, 6 of aromatic tincture, 1 of acetic ether, and 2 of tannin. The mixture, after standing for some time, is filtered, and should have a specific gravity of 0.917 to 0.920.

Dutch Method of Distilling and Manufacture of Compressed (Dry) Yeast. At *Schiedam*, *Rotterdam*, and *Delfshaven* are 300 to 400 distilleries and manufacturers of compressed yeast. The arrangement of all the distilleries is nearly the same. The stills and refrigerator stand on 1 side, and on the other 2 rows of vats, 6 in each row. Some of the vats are covered; on lifting the cover of one in which the mash has ceased fermenting, a thin, mouldy coat will be found on the surface; by tasting the mash and dipping the finger a few inches into it, no particles of crushed malt will be detected.

The capacity of the vats is nearly the same in all distilleries, and 3 to 4 men are employed in each. Work in all distilleries commences at 4 o'clock in the morning and ceases at 5 o'clock in the afternoon. The Dutch method of distilling requires comparatively little labor, which is generally done by hand, steam-engines being seldom used, and then only for pumping water. The greatest cleanliness prevails in the distillery; the walls, brick work of the stills, etc., being frequently painted, so as to give them always a new appearance.

1. The mash is brought into fermentation with compressed yeast.

2. Considerable of the mash of former distilling is utilized.

3. No sulphuric acid is used. The mash is distilled, *a*, into low wine, and, *b*, by repeated distilling of the low wine into gin (the receipt for which will be given later on).

In Schiedam, 4 vats, each having a capacity of about 500 gallons, are usually mashed every day with 250 pounds of crushed rye and 150 pounds of crushed malt; a total of 400 pounds of groats.

Mashing. At 4 o'clock in the morning water is boiled in 1 of the stills. The groats having been poured into the mashing vat, the mashing water, con-

sisting of 7 kannen* of cold and 21 kannen of warm water, is carried into the vat by 3 workmen, while the foreman manipulates with a kind of mashing scoop. When the mashing is finished, each vat contains about 175 gallons. A thermometer is seldom used for determining the temperature of the mash. The mash is allowed to stand quietly for saccharization for 1½ to 2 hours.

Setting (Anstellen). About 7 o'clock A. M. 230 gallons of wash are put into the fermenting vat, next yeast, and finally 40 gallons of cooling water, its temperature depending on that of the wash, leaving 4 inches (37 gallons) for rising space. Recapitulation of quantity of mash: One hundred and seventy-five gallons of mash, 230 gallons of wash, 40 gallons of water, 37 gallons of rising space; 482 gallons.

It will be seen from the foregoing how little labor is actually required, as only one man mashes lightly by hand, and cooling apparatuses being superfluous, as sufficient cold water and wash are added to the mash.

The mash, after having been set at 9 o'clock A. M. at 81.5° F., is allowed to ferment until 12 o'clock, during which time a thin white coating of froth is formed on the surface.

The wort from the mash in the 4 tuns is then pumped into a wort-back resembling a square wooden cooler, and standing on an elevation in the fermenting room. In place of a perforated bottom to separate the grains from the wort, the Dutch distillers use a silghtly serpentine copper siphon about 30 inches long, 4 inches wide on the top. In one of the staves of the vat, about 10 inches above the bottom, which has a fall forward of about 1 inch, is a hole closed with a cork. This latter is removed by pushing the lower pointed end of the copper siphon through the hole from the inside of the vat, allowing it to project about ¾ inch. To the upper end of the siphon is fastened a strap, which is drawn over the edge of the vat by a stone. The stone is as heavy as the copper tube full of thin mash. By raising the stone somewhat, the upper end of the copper siphon sinks down, sucks in the thin mash, and carries it through the lower end projecting through the hole in the vat, into a collecting back. When all the thin mash down to the exhaust has run off, the stone is raised up a little more and the operation repeated. All the wort is drawn off from the mash in this manner, that of the four vats running at the same time through a gutter into a collecting back, and is from here pumped into the above-mentioned wort-back. The froth (scum) formed from the time of setting (anstellen) to drawing off of the wort (9 to 12 o'clock) is prevented from entering the siphon with the thin wort, by placing a lath across the surface of the wort. When the principal part of the wort has been drawn off, water is poured upon the mash remaining in the vat and thoroughly mixed with it. It is allowed to stand quietly for 2 or 3 hours, when the heavier particles of the grains will have settled on the bottom, and the operation of drawing off the wort is repeated. About 160 gallons of sediment, *i. e.* thick mash, remain in the vat after all the wort has been drawn off. The wort stands about 4 inches deep in the wort-back, which has a total height of about 12 inches; it remains here until the next morning, when the yeast is ripe.

The formation of yeast is as follows: The yeast separates not as a high froth, but as a brownish mass resembling the formation of cream upon milk. Dark places are frequently observed upon the surface of the wort, but generally it is of a light-brown color; the lighter the color the better is the fermentation, and also the yeast. When the yeast is ripe the wort is brought back into the respective fermenting tuns. As there

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* One kanne = 4.4 gallons; 28 kannen being used. The total quantity of water in each tun is about 125 gallons. (W. T. B.)

is also a sediment of yeast on the bottom, in order to retain this a ring is placed around the tap-hole, the top yeast being held back by a lath placed across the surface of the wort. When all the wort has run off a hose is tied to the tap-hole and a workman sweeps the ripe yeast into the precipitating vessels. These are circular in form and about 15¾ inches high. The yeast, after remaining here for 3 to 4 hours, can be pressed without much difficulty, although only very little water, and that but once, and no starch has been added to precipitate it.

For pressing the yeast a canvas bag is put inside a stout press bag, and this into another press bag. The yeast is poured into this triple bag, the canvas bag containing the grains being finally lifted out. How much easier the Dutch distiller removes by this process the particles of groats from the yeast, than by washing and sifting it, as is customary in the distilleries of other countries. To press the yeast uniformly dry the press bag is not tied, but the bags, which are square, are placed one on the top of the other, the open end of the bag being bent upwards and secured between the bag itself and that lying on the top of it, a piece of linen being, for further security, laid around the open end of the bag. As 6 press bags are laid on top of each other, considerable yeast can be quickly pressed dry with one press.

The setting (stell) yeast, preserved in a fluid state, is compounded with hop water. One gallon of hops is distilled off, and the extract used for preserving the yeast required for 16 washings.

Clarifying the Wash. The wash runs directly from the still into a brick pit, and clarifies here while still warm, there being but a small opening in the cover of the pit for carrying off the vapors. About ⅔ of the clarified wash is pumped the next morning into a cooler lined with copper, and used the third day for cooling off the mash. As soon as the wash has been drawn off into the respective fermenting tuns the cooler is at once cleansed and the wash to be used the next day pumped up.

Receipt for Holland Gin. For a distillate of 12 mashings about 20 gallons of juniper berries are used; for the finest qualities of gin some licorice root and sugar are added in rectifying.

The fine flavor is imparted to the gin by the proportion of malt to the crushed rye, and the finished liquor being rectified three times. In a few distilleries 20 gallons of barley are used in place of the same quantity of rye.

Rum (Façon Rum). Prepare first a so-called rum body by pulverizing 10 pounds of catechu, placing the powder in a wide-necked bottle, pouring 1¾ gallons of alcohol of 96 per cent. over it, and letting the mixture stand for 8 days, stirring it frequently until the supernatant alcohol has acquired a dark-brown color, while the sediment has become light brown. Then pour the clear fluid into a demijohn. On the other hand, boil 45 pounds of St. John's bread, as fresh as possible, and 10 pounds of large raisins with 4½ gallons of water for about 25 minutes and press out the liquor. Mix this with 1¾ gallons of alcohol, pour it into the demijohn, stir thoroughly and allow the whole to settle. Take 1¾ to 3 quarts of this rum body to every 130 gallons of alcohol, and flavor the mixture with 1½ to 1¾ pounds of Kingston rum essence to every 20 gallons.

To Destroy Fusel Oil (Amyl Alcohol). Every distillate, be it from grain or potato mash, contains more or less fusel oil, which, by its disagreeable odor and taste, injures the flavor of the liquor, and, in preparing cordials, liqueurs, etc., destroys the effect of the aromatic admixtures. The best means hitherto discovered of depriving liquors of fusel oil is to pass them through coarsely-pulverized charcoal, distributed as follows in a series of casks. Each vessel must have a double bottom, the false one being perforated and placed a few inches above the true. Upon this per-

forated board a layer of chopped, lixiviated straw ¾ to 1 inch thick is laid, and over the straw a stratum of fine gravel the size of large peas. This is covered with a pretty thick stratum of the charcoal, previously freed from dirt and dust by washing; upon this is spread a piece of close canvas, and pressed down by a thin bed of river sand. The cylinder or cask should be filled with these successive layers to within 2 inches of its top, and is then closed air-tight. Immediately below the head a hole is bored in the side for receiving an overflow tube, which is either screwed rectangularly to another elbow pipe or is bent so as to enter tight into a hole beneath the false bottom of the second cylinder or cask. In this way the series may be continued to any desired number of vessels; the last discharging the purified spirit into the store-barrel. The foul alcohol must be made to flow into the bottom space of the first cylinder down through a pipe in communication with a charging vessel, placed upon such an elevation as to give sufficient pressure to force the spirits up through the series of filters, the supply pipe being provided with a regulating stop cock.

To Purify Alcohol and Liquors. Cover 10 pounds of animal charcoal with a few inches of water, add 1¾ ounces of concentrated sulphuric acid, agitate the mixture thoroughly, and let it stand over night. Draw off the water the next day, and wash the mixture with fresh water until the latter has no longer an acid taste and does not redden litmus paper. The drained-off charcoal is then placed upon the perforated bottom of the filtering apparatus, covered with a layer of lixiviated straw ¾ to 1 inch thick. Upon this is placed another perforated bottom, and upon this a mixture of 1 pound of magnesia, 20 pounds of wood charcoal, and 5½ pounds of pyrolusite. This is also covered with a layer of lixiviated straw and a finely-perforated plate upon which comes a thick layer of river sand previously washed and dried. The liquor to be purified is then compounded with ¾ ounce of spirit of ammonia to every 20 gallons. The liquor is allowed to remain quietly for a few days and is then gradually passed into the filter, where it remains for 3 days, when the purified liquor is drawn off and the filter replenished. This apparatus may be used for an entire year without renewing the filtering material.

To Remove the Taste of the Barrel from Whiskey, add a little good olive oil to it.

WINES. *Bordeaux.* It is best to use a light Hungarian red wine. Mix with 50 gallons 1 pint of kino, 2 to 3 ounces of sulphate of iron dissolved in 1 quart of boiling water, and 1 wineglassful of extract of orris root and a like quantity of raspberry extract.

Burgundy. Mix in a barrel 100 parts of white wine, 10 of the juice of black cherries, 6 of crushed large raisins, 6 of pulverized cinnamon, ½ of pulverized crude tartar, and 50 of must concentrated by evaporation; allow the mixture to ferment in a cool place, and then rack the wine into another barrel.

Champagne. The following process of manufacture is observed in champagne: Late in the fall the must of different grapes is brought and poured in large vats. In December, before fermentation is entirely completed, the wine is clarified with isinglass and racked into well-stoppered bottles. The bottles are then laid on their sides with their mouths sloping downwards at an angle of about 20 degrees, in order that any sediment may fall in the neck. At the end of a few days the inclination of the bottles is increased, and the slimy substances collected over the cork are from time to time dexterously discharged by a skilled workman opening the bottles. Every time the bottles are opened, 1 teaspoonful of rock-candy is added to each bottle. When no more sediment is collected in

the neck, the bottles are corked with long corks by special machines, and wired.

Artificial Champagnes. Champagne Liqueur. Boil 8¾ pounds of the finest loaf sugar with 1 gallon of water, add gradually while the water is boiling ½ gallon of alcohol of 90 per cent., and then filter the mixture.

The above liqueur is added to all the following compounds.

Chandon et Moet (Green Seal). Mix the above liqueur with 7½ gallons of white wine and 1 quart of cognac.

Louis Röderer (Green and Bronze Seal). Mix the champagne liqueur with 7½ gallons of white wine, 1 bottle of cognac, and 4 drops of sulphuric ether dissolved in cognac.

Heidesick et Cie. (Sealed with Tinfoil). Mix the champagne liqueur with 7½ gallons of white wine and ¾ pint of cognac.

Lemberg Geldermann et Deitz (Sealed with Tinfoil). Mix double the quantity of champagne liqueur with 7½ gallons of white wine and ¾ pint of cognac, in which 2 roots of celery, carefully cleansed, have been previously digested for 4 hours.

Schneider (Yellowish-green Seal). Mix the champagne liqueur with 7½ gallons of wine, 1 bottle of cognac, and 3 drops of strawberry essence.

Fleuer de Sillery (Sealed with Tinfoil). Mix the champagne liqueur with 7½ gallons of white wine and 1 bottle of cognac, in which 4 roots of celery have been previously digested for 8 hours.

Jacquesson et Fils (Sealed with Tinfoil). Mix the champagne liqueur with 7½ gallons of white wine and 1¾ pints of cognac.

The bottles are corked with champagne corks and laid on their sides with their mouths sloping downward. They are recorked the next day with the corking machine. The corks, before using them, must be laid in hot water, and before placing them in the machine, moistened with sugar syrup, and as soon as driven into the bottles tied with cord, and finally wired.

Madeira. Digest at a moderate heat 10 ounces of purified honey, 13 ounces of the strongest spirit of wine, ½ ounce of hop tops, and 3 quarts of French wine, then add ½ ounce of tincture of burned sugar, and filter the wine into bottles.

Malaga. Put 15 gallons of white *calabre* (white-wine must boiled down to ⅓ of its volume), 7 gallons of red *calabre* (red-wine must boiled down to ⅓ of its volume), 2 gallons of spirit of wine, and 1 wineglassful of *essence de Goudron* dissolved in spirit of wine in a barrel; fill the barrel full with light white wine and let it remain in a warm room about 4 to 6 weeks. Then color the wine with sugar color, but not too brown, and finally clear it with isinglass.

The *essence de Goudron* is prepared by allowing 1 pound of Swedish wood tar to stand for a few weeks with 1¾ pints of spirit of wine, shaking it frequently, and finally drawing off the supernatant liquor.

Port Wine. Compound 100 gallons of old red wine with 10 to 15 per cent. of pure honey, and let the mixture ferment slowly in a warm room. When the sweet taste has almost disappeared, add 4½ gallons of spirit of wine previously mixed with 2 quarts of kino. Should the wine not be dark enough, add some heavy red wine, or color with mallow blossoms.

To Improve Wine Must. Pulverize pure common salt, calcine it in a pan, and distribute it in the barrels in the proportion of ¼ ounce of salt to 15 gallons of must.

A Remedy for Ropiness or Viscidity of Wines is the bruised berries of the mountain ash in a somewhat unripe state, of which 1 pound, well stirred in, is sufficient for a barrel. After agitation the wine is left at rest for a day or two, and then racked off into another barrel, and finally cleared and bottled.

To Remove the Taste of the Barrel from Wine is best accomplished by agitating the wine for some time with a 115 spoonful of olive oil. An essential oil, the chief cause of the bad taste, combines with the fixed oil and rises with
116 it to the surface.

SCIENTIFIC AMERICAN CYCLOPEDIA

BITTERS

1903

Bitters.—Bitters are considered as tonic and stomachic, and to improve the appetite when taken in moderation. The best time is early in the morning, or an hour before meals. An excessive use of bitters tends to weaken the stomach. They should not be taken for a longer period than a fortnight at one time, allowing a similar period to elapse before again having recourse to them.

Angostura.—4 oz. gentian root; 10 oz. each calisaya bark, Canada snake root, Virginia snake root, licorice root, yellow bark, allspice, dandelion root, and Angostura bark; 6 oz. cardamom seeds; 4 oz. each balsam of tolu, orangetis, Turkey rhubarb, and galanga; 1 lb. orange peel; 1 lb. alkanet root; 1½ oz. caraway seed; 1½ oz. cinnamon; ½ oz. cloves; 2 oz. each nutmegs, coriander seed, catechu and wormwood; 1 oz. mace; 1¼ lb. red sanders wood and 8 oz. turmeric. Pound these ingredients and steep them for fifteen days in 50 gal. proof spirit; before filtering, add 30 lb. honey.

Aromatic.—Macerate 2¼ lb. ground dried small orange apples; ¼ lb. ground dried orange peel; 2 oz. ground dried calamus root; 2 oz. ground dried pimpinella root; 1 oz. ground dried cut hops, for fourteen days, with 10 gal. of spirit at 45%; press, and add 2½ pt. brown sugar sirup. Filter. Color dark brown.

Berlin Bitters.—Dissolve in 3 qt. 80% alcohol Tr., 40 drops oil of juniper, 40 drops oil of coriander, 20 drops oil of angelica, 20 drops Indian seed oil, 22 drops oil of ginger; add 3 qt. of water and ½ lb. of sugar to this solution. Filter and color brown.

Boker's.—1½ oz. quassia; 1½ oz. calamus; 1½ oz. catechu, powdered; 1 oz. cardamom; 2 oz. dried orange peel. Macerate for ten days in ½ gal. strong whisky, and then filter and add 2 gal. water. Color with mallow or malva flowers.

Brandy.—Grind to coarse powder 3 lb. gentian root, 2 lb. dry orange peel, 1 lb. cardamom seeds, 2 oz. cinnamon, 2 oz. cochineal. Infuse ten days in 1 gal. brandy, 8 gal. water, and filter.

Hamburg.—Grind to a coarse powder 2 oz. agaric, 5 oz. cinnamon, 4 oz. cassia buds, ½ oz. grains of paradise, 3 oz. quassia wood, ¾ oz. cardamom seeds, 3 oz. gentian root, 3 oz. orange apples dried, 1½ oz. orange peel. Macerate with 4¼ gal. 95% alcohol, mixed with 5¾ gal. water; add 2¾ oz. acetic ether. Color, brown.

Hostetter's.—The following is given as the composition of Hostetter's bitters: Calamus root, 2 lb.; orange peel, 2 lb.; Peruvian bark, 2 lb.; gentian root, 2 lb.; Colombo root, 2 lb.; rhubarb, 8 oz.; cinnamon, 4 oz.; cloves, 2 oz.; diluted alcohol, 4 gal.; water, 2 gal.; sugar, 2 lb.

Orange.—Macerate 6 lb. orange peel for twenty-four hours with 1 gal. water, cut the yellow part of the peel from off the white, and chop it fine; macerate with 4¾ gal. 95% alcohol nutmeg, and 75 cayenne pepper seeds. Infuse them, well bruised, in 8 gal. proof spirit, for fifteen to twenty days, stirring every day. Draw off and filter.

Spanish.—Grind to coarse powder 5 oz. polypody, 6 oz. calamus root, 8 oz. orris root, 2½ oz. coriander seed, 1 oz. centaurium, 3 oz. orange peel, 2 oz. German chamomile flowers; then macerate with 4¾ gal. 95% alcohol, and add 5¼ gal. water and 1½ oz. sugar. Filter and color brown.

Stomach.—Grind to a coarse powder ½ lb. cardamom seeds, ½ lb. nutmegs, ¼ lb. grains of paradise, ½ lb. cinnamon, ¼ lb. cloves, ¼ lb. ginger, ¼ lb. galanga, ¼ lb. orange peel, ½ lb. lemon peel; then macerate with 4¾ gal. 95% alcohol, and add a sirup made of 4½ gal. water and 12 lb. sugar; filter.

Wild Cherry.—Wild cherry bark, 4 lb.; squaw vine (partridge berry), 1 lb.; juniper berries, 8 oz. Pour boiling water over, and let stand for twenty-four hours; strain, and again pour boiling water on the ingredients; let macerate for twelve hours, then express and filter through paper, so that the whole will make 5 gal., to which add 3½ lb. of sugar, 1½ gal. molasses, 6 oz. tincture of peach kernels, 3 oz. tincture of prickly ash berries, 2 qt. alcohol.

Wine.—1. Bruised gentian root, fresh orange and lemon peel, of each 1¼ oz.; white wine, 1 qt.; digest for a week, and strain.

2. Cinchona bark bruised, 8 oz.; white canella, 1½ oz.; juniper berries, lemon peel, and winter's bark, of each 1¼ oz.; carbonate of soda, ¾ oz.; Madeira wine, 1¾ gal.; digest for a week.

3. French lemon peel, 1 lb.; dried orange peel, ½ lb.; bruised gentian root, ¼ lb.; Cape wine, 1 gal.; as before.

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CIDER

Cider.—*How to Make Good Cider and to Keep It.*—In localities where the apple crop is abundant the preparation of cider for market is a profitable industry when intelligently undertaken, and there are few beverages more palatable and less harmful than cider when properly prepared. Unfortunately, there are few farmers who really know how to make good cider or how to care for and keep it when made.

In the first place, apples not perfectly sound and well ripened are not fit for making cider. The russet is one of the best of apples for this purpose, but other and more commonly available varieties need not be slighted.

To prevent bruising the fruit intended for the cider press should always be hand picked. After sweating each apple should be wiped dry, examined, and any damaged or decayed fruit thrown out and used for making vinegar cider.

In the grinding or pulping operation the seed is often crushed and is apt to taint the juice, so that despite the loss and extra time required it is always better to core the apples before grinding them, as the cider will not only taste and look better, but keep better. A cheap and

handy coring machine is shown in Fig. 1. In this the coring tube, which may be of tin, free from iron rust, projects through a common bench or table, and is surrounded by an ordinary furniture spring, P, which supports a piece of wood, A. This has a hole in the center of it, over and partly into which the apple is placed. The lever, D, on which the piece of wood, B, similar to A, but having an aperture only large enough to admit the coring tube, is loosely hung by side pins, is held in position by the spring, S. The operation of the machine will be readily understood by referring to Fig. 2, in which it is shown in section.

All ironwork about the mill or press (rings, rivets, etc.) should be tinned or coated with good asphaltum varnish, as the color and sometimes taste of the cider are apt to be affected by contact with the rusty metal.

In pressing the pomace many of the best cider makers prefer to use hair cloth in place of straw between the layers, as it is more cleanly and does not affect the taste of or add anything to the expressed juice.

As the cider runs from the press it should be filtered through a hair sieve into a clean wooden vessel capable of holding as much juice as can be extracted in one day.

Under favorable conditions the fine pomace will rise to the surface in about twenty-four hours—sometimes less—and in a short time grow very thick. Then it should be watched, and when white bubbles begin to appear at the surface, the liquid should be drawn off slowly from a faucet placed about three inches from the bottom of the tank, so as not to disturb the lees. The liquid drawn off should be received in clean, sweet casks, and must be watched. As soon as white bubbles of gas appear at the bunghole, it must be drawn off (racked) into clean casks as before, and this racking repeated as often as necessary until the first fermentation is completely at an end. Then the casks should be filled up with cider in every respect like that already contained in it and bunged up tight. Many cider makers add a gobletful of pure olive oil to the cider before finally putting in the bung and storing.

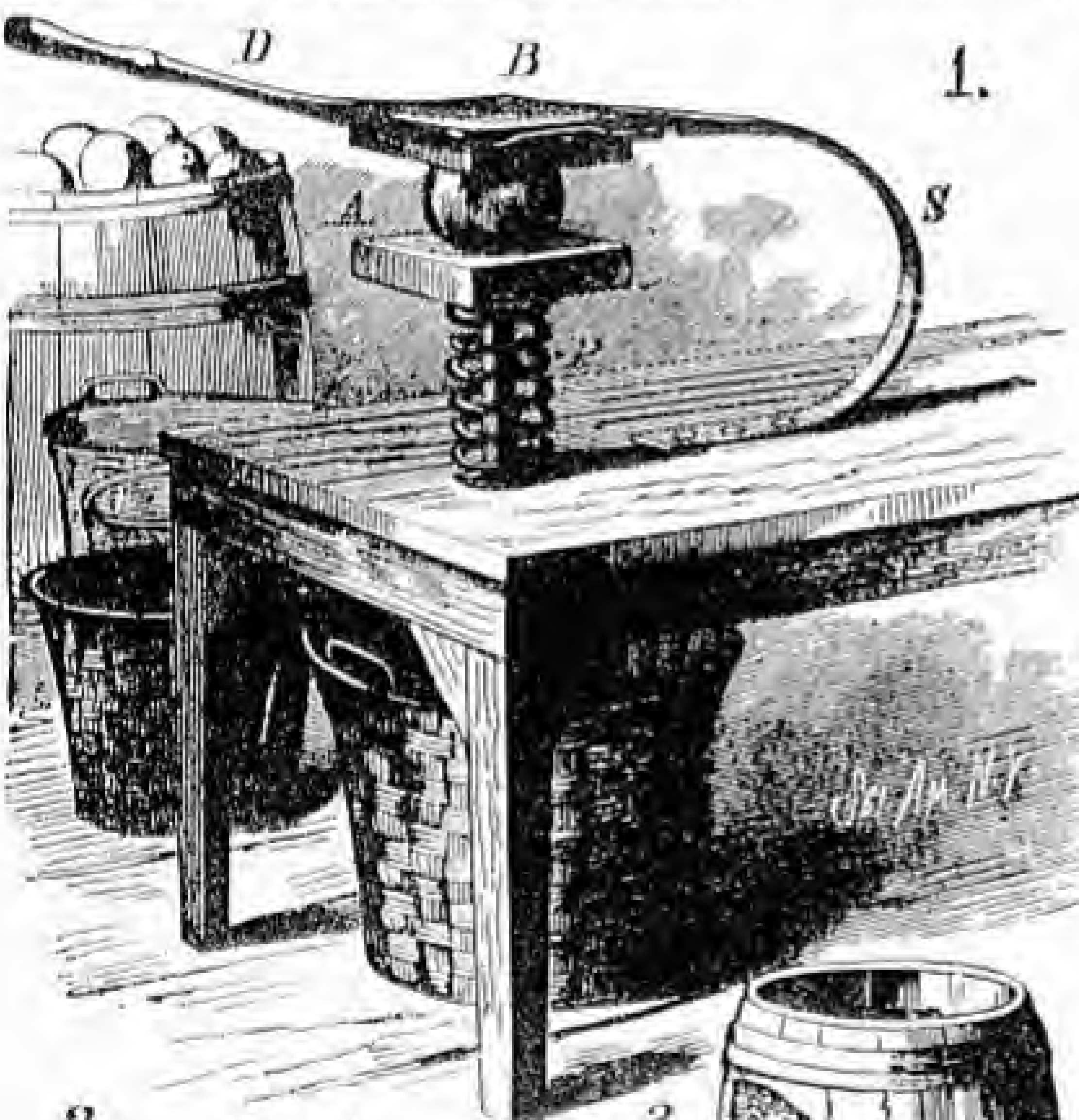
If it is desired to keep cider perfectly sweet—and this is rarely the case—it should be filtered on coming from the press, and then sulphured by the addition of about one-quarter ounce of calcium sulphite (sulphite of lime) per gallon of cider, and should be kept in small, tight, full barrels. The addition of a little sugar—say one-quarter of a pound per gallon—improves the keeping qualities of tart cider.

An easily constructed cider filter is shown in Fig. 3, and consists in a barrel provided with a tap near the bottom. The lower part is filled with dry wood chips covered with a piece of flannel. Over this a layer of clean ryestraw is packed down, and then the barrel is filled with clean quartz sand, not too fine.

When the first fermentation of cider has been checked and the liquid barreled, it should be allowed to stand until it acquires the proper flavor.

Much of the excellency

1.



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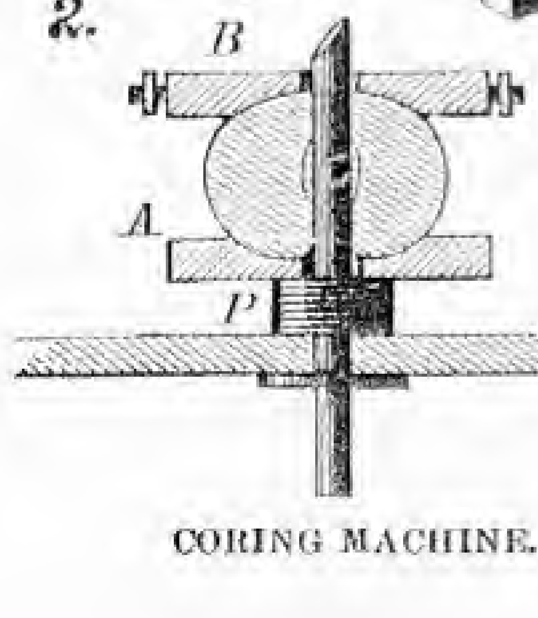

CORING MACHINE.

3.

FILTER.

of cider depends upon the temperature at which the fermentation is conducted. The casks containing the juice should be kept in a cellar, if possible, where the temperature does not exceed 50° Fah. When left exposed to the air, or kept in a warm place, much of the sugar is converted into vinegar and the liquor becomes hard and rough. On the contrary, when the fermentation is conducted at a low temperature, nearly the whole of the sugar is converted into alcohol and remains in the liquid instead of undergoing acetification. The change from alcohol to vinegar (acetous fermentation) goes on most rapidly at a temperature of about 95° Fah., and at a lower temperature the action becomes slower, until at 46° Fah. no such change takes place. Independently of the difference in quality of fruit used, the respect of temperature is one of the chief causes of the superiority of the cider made by one person over that made by another in the same neighborhood.

The more malic acid and less sugar present, the less the tendency to acetous fermentation; hence it often happens that tart apples produce the best cider. But cider made from such apples can never equal in quality that prepared at a low temperature from fruit rich in sugar, which, if properly cared for, will keep good twenty years.

When the first fermentation has subsided, and the liquor has developed the desired flavor in storage, it is drawn off into other barrels which have been thoroughly cleansed and sulphured, either by burning in the bunghole a clean rag dipped in sulphur or, what is better, by thoroughly rinsing the inside with a solution of bisulphite of calcium prepared by dissolving about a quarter pound of the sulphite in a gallon of water.

The isinglass—six ounces or more (in solution) to the barrel—should be stirred in as soon as transferred, and then a sufficient quantity of preserving powder of bisulphite of lime (not sulphate or sulphide), previously dissolved in a little of the cider, to entirely check fermentation. The quantity of this substance required rarely exceeds a quarter of an ounce to the gallon of cider. A large excess must be avoided, as it is apt to injuriously affect the taste.

Some makers sweeten their cider by additions, before fining, of sugar or glucose, the quantity of the former varying from three-quarters of a pound to one and a half pounds, while as a substitute about three times this quantity of glucose is required. Sweetened cider, when properly cared for, develops by aging a flavor and sparkle resembling some champagnes. Such ciders are best bottled when fined.

The following are the methods by which some of the beverages found in the market under the name of "champagne cider" are made:—

1. Cider (pure apple) .... 3 bbl.
   Glucose sirup (A)........ .... 4 gal.
   Wine spirit... .... 4 "

The glucose is added to the cider, and after twelve days' storage in a cool place the liquid is clarified with one-half gallon of fresh skimmed milk and eight ounces of dissolved isinglass. The spirit is then added and the liquor bottled on the fourth day afterward.

2. Pale vinous cider .. .. 1 hhd.
   Wine spirit.......... .... 3 gal.
   Glucose about ....30 lb.

The liquid is stored in casks in a cool place for about one month, when it is fined down with two quarts of skimmed milk and bottled. Much of this and similar preparations are doubtless sold for genuine champagne.

3. Pineapple cider................... 20 gal.
   Wine spirit.... .... 1 "
   Sugar.................... .... 6 lb.

Fine with one gallon of skimmed milk after two weeks' storage in wood and bottle.—*Scientific American Supplement.*

Cider, Artificial.—Soft water, 25 gal.; tartaric acid, 2 lb.; New Orleans sugar, 25 lb.; yeast, 1 pt. Put into clean cask with bung out, and allow to stand twenty-four hours. Then add 3 gal. spirits and let stand forty-eight hours. It will keep well if not left exposed to the air, and if the cask is sweet.

Bottling Cider.—To have good bottled cider, it is necessary first that care should be taken in its manufacture. Apples picked by hand and perfectly ripe and sound are essential to the best quality. They should lie some time after picking. They should then be sorted, their surface wiped dry, and all the rotten fruit rejected. The cider may then be made in the usual manner by grinding and pressing. The cider should then be stored in a cool place to mature. After three or four months it should be racked off carefully, and then fined by adding to each hogshead a pound of isinglass finings. In two weeks from the time that the finings are added it should be again racked off, and if found sufficiently clear and sparkling it is ready for bottling; if not, it should be again fined and allowed to stand two weeks. Before bottling, the bung should be left out of the casks for ten or twelve hours to permit the escape of carbonic acid gas. The cider may then be placed in bottles, and the corks loosely placed in. The bottles should then be allowed to stand twenty-four hours. The corks may then be driven in and wired down. If the corks are driven in and wired when the cider is first put into the bottles there will be great danger of breaking the bottles by the accumulating pressure of the gas. All additions of flavoring materials are a decided damage to cider made from a fine quality of fruit, though they may improve juice of a poor quality. If the directions here given be strictly followed, a delicious cider will be produced.

Cider, to Can.—Cider may be preserved sweet for years by putting it up in airtight cans, after the manner of preserving fruit. The liquor should be first settled and racked off from the dregs, but fermentation should not be allowed to commence before canning.

Champagne Cider.—Good, pale vinous cider, 1 hhd.; proof spirit, 3 gal.; honey or sugar, 14 lb. Mix well, and let them remain together in a moderately cool place for one month, then add orange flower water, 3 pt., and in a few days fine it down with skimmed milk, ½ gal. A similar article, bottled in champagne bottles, silvered and labeled, is said to be sometimes sold for champagne.

Cider, to Clear.—Ground horseradish, 4 pts.; nearly 1 lb. of thick gray filtering paper to the barrel; shake or stir, until the paper has separated into small shreds; let it stand twenty-four hours, then draw off the cider by means of a siphon or stopcock.

Cider, to Improve.—Cider, 1 hogshead; rum, weak flavored, 2 gal.; alum, dissolved, 1 lb.; honey or coarse sugar, 15 lb.; sugar coloring,

q. s.; bitter almonds, ½ lb.; cloves, ½ lb.; mix, and after three or four days fine down with isinglass. For champagne cider, omit the coloring, and fine with 2 qts. milk; this will render it very pale.

Cider, to Keep.—1. Place in each barrel immediately on making, mustard, 4 oz.; salt, 1 oz.; ground chalk, 1 oz. Shake well.

2. Mustard seed, 1 oz.; allspice, 1 oz.; olive ¼ pt.; alcohol, ½ pt.

Made Cider.—An article under this name is made in Devonshire, chiefly for the supply of the London market, it having been found that the ordinary cider will not stand a voyage to the metropolis without some preparation. The finest quality of made cider is simply ordinary cider racked into clean and well-sulphured casks; but the mass of that which is sent to London is mixed with water, molasses and alum. The cider sold in London under the name of Devonshire cider would be rejected even by the farmers' servants in that county.

How to Preserve Cider.—A pure, sweet cider is only obtainable from clean, sound fruit, and the fruit should therefore be carefully examined and wiped before grinding.

In the press, use hair cloth or gunny in place of straw. As the cider runs from the press, let it pass through a hair sieve into a large open vessel that will hold as much juice as can be expressed in one day. In one day, or sometimes less, the pomace will rise to the top, and in a short time grow very thick. When little white bubbles break through it, draw off the liquid through a very small spigot placed about 3 in. from the bottom, so that the lees may be left behind. The cider must be drawn off into very clean, sweet casks, preferably fresh liquor casks, and closely watched. The moment the white bubbles, before mentioned, are perceived rising at the bunghole, rack it again. It is usually necessary to repeat this three times. Then fill up the cask with cider in every respect like that originally contained in it, add a tumbler of warm, sweet oil, and bung up tight. For very fine cider it is customary to add at this stage of the process about ½ lb. of glucose (starch sugar) or a smaller portion of white sugar. The cask should then be allowed to remain in a cool place until the cider has acquired the desired flavor. In the meantime clean barrels for its reception should be prepared, as follows: Some clean strips of rags are dipped in melted sulphur, lighted and burned in the bunghole, and the bung laid loosely on the end of the rag so as to retain the sulphur vapor within the barrel. Then tie up ½ lb. of mustard seed in a coarse muslin bag, and put it in the barrel, fill the barrel with cider, add about ¼ lb. of isinglass or fine gelatine dissolved in hot water.

This is the old-fashioned way, and will keep cider in the same condition as when it went into the barrel, if kept in a cool place, for a year.

Professional cider makers are now using calcium sulphite (sulphite of lime), instead of mustard and sulphur vapor. It is much more convenient and effectual. To use it, it is simply requisite to add ⅛ to ¼ of an ounce of the sulphite to each gallon of cider in the cask, first mixing the powder in about a quart of the cider, then pouring it back into the cask and giving the latter a thorough shaking or rolling. After standing bunged several days to allow the sulphite to exert its full action, it may be bottled off.

The sulphite of lime (which should not be mistaken for the sulphate of lime) is a commercial article, costing about 40 cents a lb. by the barrel. It will preserve the sweetness of the cider perfectly, but unless care is taken not to add too much of it, it will impart a slight sulphurous taste to the cider. The bottles and corks used should be perfectly clean, and the corks wired down.

A little cinnamon, wintergreen, or sassafras, etc., is often added to sweet cider in the bottle, together with a drachm or so of bicarbonate of soda at the moment of driving the stopper. This helps to neutralize the acids, and renders the liquid effervescent when unstoppered; but if used in excess it may prejudicially affect the taste.

Raisin Cider.—This is made in a similar way to raisin wine, but without employing sugar, and with only 2 lb. of raisins to the gallon, or even more, of water. It is usually fit for bottling in ten days, and in a week longer is ready for use.

See *Wines (British)*.

Cider, to Keep Sweet.—When the cider has reached the flavor required, add 1 to 2 tumblers of grated horseradish to each barrel of cider.

Cheap Cider.—Mix well together 10 gal. cold water, 7½ lb. brown sugar, ¼ lb. tartaric acid, add the juice expressed from 2 or 3 lb. dried sour apples, boiled.

Continued from page 2736

hand. He also remarks that the tissues, by repeated application of glycerine, may be exhausted of their ferment, and yet be changed but little, if at all, in other respects.

POISONOUS QUALITIES OF BROMIDE OF POTASSIUM.

Bromide of potassium has of late years been a great favorite with the medical profession on account of the many virtues it is said to possess in cases of nervous diseases and cerebral affection. We are, however, in a recent medical thesis, solemnly warned of various ills that have attended its use, such as a decrease of strength, muscular weakness, trembling of the hands, emaciation, loss of appetite, and many other evils. These, however, are said, on the other hand, to depend probably on the excessive use of this substance, or on its application in cases where the general symptoms would properly forbid its employment.

RAPID METHOD OF TINNING.

A valuable recipe for tinning copper, brass, and iron in the cold, and without complicated apparatus, has recently been published by Professor Stolba, of Prague, which we present for the consideration of our readers. A prerequisite is that the article to be tinned be perfectly free from oxide or grease of any kind, it being necessary that the surface be cleaned in the most careful manner, although it is immaterial whether this be done by mechanical or chemical means.

The substances used in the process are, first, powdered zinc, which may be the ordinary zinc dust, called sometimes zinc gray; but that which is prepared expressly for the purpose will be best. For this it is only necessary to melt some pure zinc, and pour it into a previously warmed iron mortar. As soon as it has become hardened it can be readily pulverized, and should then be freed from its coarser grains by sifting. The proper fineness is that of ordinary writing sand.

The next ingredient is a five to ten per cent. solution of the salt of tin (simple chloride of tin), to which is to be added as much powdered cream of tartar as can be taken up on the point of a knife. Next is required a piece of sponge, or a pad of some kind. The process of tinning is extremely simple. The pad is first to be dipped in the solution of salt of tin, and applied to the object to be tinned, so as to moisten it thoroughly. A small quantity of the zinc powder having been spread out on a glass plate, a portion of this powder is then to be taken up by the pad, and quickly and firmly rubbed upon the article in hand. The tinning makes its appearance almost immediately; and in order that the surface may be coated uniformly, it is only necessary to dip the pad alternately into the solution of tin (which is to be kept in a little dish) and into the zinc powder, and then to apply it. After the operation is completed, which, for small objects requires only one or two minutes, the article is to be washed off in water, and then cleaned with Tripoli, or polishing powder. The effect

Continued on page 2764

LIQUORS AND CORDIALS

Liquors (Liqueurs) and Cordials.—Many of the following receipts for liqueurs and cordials come from the "Brewer and Distiller." By J. Gardner, F. C. S., but the majority of the receipts were specially translated from the French.

Liquors and cordials are stimulating beverages, formed of weak spirit, aromatized and sweetened. The manufacture of liqueurs constitutes the trade of the compounder, rectifier, or liqueurist.

The materials employed in the preparation of liquors or cordials are rain or distilled water, white sugar, clean flavorless spirit, and flavoring ingredients. To these may be added the substances employed as finings, when artificial clarification is had recourse to.

The utensils and apparatus required in the business are those ordinarily found in the wine and spirit cellar; together with a copper still, furnished with a pewter head and a pewter worm or condenser, when the method by distillation is pursued. A barrel, hogshead, or rum puncheon, sawn in two, or simply unheaded, as the case may demand, forms an excellent vessel for the solution of the sugar; and two or three fluted funnels, with some good white flannel, will occasionally be found useful for filtering the aromatic essences used for flavoring. Great care is taken to insure the whole of the utensils, etc., being perfectly clean, sweet, and well seasoned, in order that they may neither stain nor flavor the substances placed in contact with them.

French liqueurists dististinguish their liqueurs as "eaux" and "extraits," or liqueurs which, though sweetened, are entirely devoid of viscidity; and "baumes," "crêmes," and "huiles," which contain sufficient sugar to impart to them a sirupy consistence; usually "crêmes" contain less alcohol than "huiles."

The French names are retained in the receipts. Where it is not possible to make the liquors by distillation, the receipts which say by essences should be chosen. O. p. means over proof, u. p. means under proof. (See **Alcohol.**) The abbreviations of the metric system should not be forgotten, l. = liter ; gr. = gramme; k. = kilogramme. It should be remembered the art of the liquorist can only be obtained by long practice; still with ordinary care very good results can be obtained. Do not get the liquors too aromatic. This is the fault of most amateurs. All liquors should be bottled and labeled with neat labels, and the top sealed with wax or tinfoil.

Absinthe.—1. From the tops of *Absinthium majus*, 4 lb.; tops of *Absinthium minus*, 2 lb.; angelica root, *Calamus aromaticus*, Chinese aniseed, and leaves of dittany of Crete, of each 15 grn.; brandy or spirit at 12 u. p., 4 gal.; macerate for ten days, then add water, 1 gal.; distill 4 gal. by a gentle heat, and dissolve in the distilled spirit crushed white sugar, 2 lb.

2. Spirit of wormwood, 172 parts; best sugar, 125 parts; orange flower water, 13¼ parts; water, 125 parts. Dissolve the sugar in the water, and then add the orange flower water; thoroughly mix in the sirup the white of one egg. Next add the wormwood spirit, and heat the mixture very gently over a water bath, so as just to coagulate the albumen; immediately remove the liquid from the fire and filter.

Crême d'Absinthe.—(By Essences.)—Essence absinthe, 0·60 gr.; essence of English mint, 0·60 gr.; essence of anise, 3 gr.; essence of fennel, 0·80 gr.; alcohol, etc., same as Chartreuse.

Absinthe of Montpellier.—Large absinthe (dried), k. 0·250; green anise, k. 0·600; fennel, k. 0·400; coriander, k. 0·100; angelica seed, k. 0·50; alcohol at 85° 9·5 l. Digest the ingredients for twelve hours with alcohol, then add 4·5 l. of water, then distill 9·5 l. of perfumed spirit. Color as follows: dried hyssop (herb and flowers), k. 0·75; dried melisse (balm), k. 0·75; small absinthe, k. 0·100. The small absinthe is broken in small pieces, the hyssop and melisse are reduced to powder in a mortar. Digest the whole of the perfumed spirit at a low temperature. Allow it to cool. To this colored liquor add 5·5 l. of perfumed spirits, and reduce to 74° with 0·5 l. of water to produce 10 liters of the product.

Absinthe of Lyons.—Large absinthe, dried, 0·300 k.; green anise, 0.8 k.; fennel, 0·4 k.; angelica seeds, 0·050 k.; coloring, lemon balm, 0·1 k.; dried absinthe (small), 0·1 k.; hyssop (herb and flowers) 0·05 k.; dried veronica, 0·5 k.

Ageing Liquor.—Twenty lb. caustic soda at 60° Tw., 20 lb. white arsenic in powder. Boil until all the arsenic is dissolved. Make a solution of 3 lb. of chlorate of potash in 4 gal. of water; add the first liquor until it stands at 28° Tw.

Alkermes.—This liqueur is highly esteemed in some parts of the South of Europe.

1. Bay leaves and mace, of each 1 lb.; nutmegs and cinnamon, of each 2 oz.; cloves 1 oz., all bruised; cognac brandy, 3½ gal.; macerate for three weeks, frequently shaking, then distill over 3 gal., and add of clarified spirit of kermes, 18 lb.; orange flower water, 1 pt.; mix well and bottle. This is the original formula for the Alkermes de Santa Maria Novella, which is much valued.

2. Spice as last; British brandy, 4 gal.; water, 1 gal.; macerate as before, and draw over 4 gal.; to which add, of sirup, 2 gal., and sweet spirit of niter, ¼ pt. Cassia is often used for cinnamon. Inferior to the last.

Alkermès, de Florence. (By Essences.)—Ess. of calamus, 0·30 gr.; ess. of cloves, 0·50 gr.; ess. of Ceylon cinnamon, 0·20 gr.; ess. of roses, 0·40 gr.; extract of jasmine, 3 gr.; extract of anise, 3 gr.; alcohol, same as for chartreuse. Color with cochineal.

Crême d'Ananas.—Bananas, 800 gr.; alcohol, 4 l. Crust and infuse the bananas for a week in alcohol, then pass the liqueur through a silk strainer, pour melted sugar into 2·20 l. of water, add 0·050 l. of an infusion of vanilla. Color yellow with caramel.

Aniseed Cordial.—1. From aniseed, 2 oz., or essential oil, 1½ dr., and sugar, 3 lb. per gal. It should not be weaker than about 45 u. p., as at lower strengths it is impossible to produce a full-flavored article without its being milky or liable to become so.

2. *Anisette de Bordeaux.*—1. Foreign.—Aniseed, 4 oz.; coriander and sweet fennel seeds, bruised, of each 1 oz.; rectified spirit, ½ gal.; water, 3 qts.; macerate for five or six days, then draw over 7 pt., and add of lump sugar 2½ lb.

2. English.—Oil of aniseed, 15 drops; oil of cassia and caraway, of each 6 drops; rub them with a little sugar and then dissolve in spirit 45 u. p., 3 qt., by well shaking them together; filter, if necessary, and dissolve in the clear liquid, 1½ lb. of sugar.

Anisette. (By Essences.)—1. Ess. Chinese (star) anise, 7 gr.; ess. anise, 2 gr.; ess. of fennel, 0·30 gr.; ess. of coriander, 0·10 gr.; ess. of sassafras, 0·60 gr.; extract of orris, 6 gr.; extract of ambergris, 0·30 gr. Alcohol, etc., same as chartreuse.

2. Chinese anise, 5 gr.; essence anise, 2 gr.; essence of fennel, 0·60 gr.; essence of coriander, 0·10 gr.; essence of sassafras, 0.40 gr.; extract of orris, 4 gr.; extract of ambergris, 0·60 gr.; alcohol, 85°, 3·20 l.; water, 3·90 l.; sugar, 4·375 k.

Aqua Reale.—Dissolve 2 fl. dr. oil of lemon; 1½ fl. dr. oil of orange peel; 54 drops oil of cinnamon; 60 drops oil of cloves; 60 drops oil of mace; 4 fl. dr. vanilla essence; 1½ fl. dr. ambergris essence. Dissolve 13 lb. sugar in 2 gal. water, filter, and add to the above solution.

Arrack.—A spirituous liquor procured by distillation from palm wine, or a fermented infusion of rice. It is imported from the East Indies, and much used to make punch. When sliced pineapples are placed in arrack, and the spirit kept for some time, it acquires a most delicious flavor, and is thought to be unrivaled for making nectarial punch.

Arrack, Factitious.—*Syn.* Mock Arrack. Vauxhall Nectar.—*Prep.* Dissolve 23 gr. flowers of benzoin (benzoic acid) in 1 qt. good pale Jamaica rum. Sold for arrack.

Balm of Molucca—From mace, 1 drm.; cloves, ½ oz.; clean spirit, 22 u. p., 1 gal.; infuse for a week in a well-corked carboy or jar, frequently shaking, color with burnt sugar q. s., and to the clear tincture add 4½ lb. of lump sugar; dissolve in pure soft water, ½ gal. On the Continent this takes the place of the cloves of the English retailer.

Crême des Barbades.—1. Lemons, sliced, 2 doz.; citrons, sliced, ½ doz.; fresh balm leaves, 8 oz.; proof spirit, 4 gal.; digest for a fortnight, then express the liquor, strain, and add 2 gal. each of clarified sirup and pure water.

2. The fresh peels of 3 oranges and 3 lemons; cassia bruised, 4 oz.; mace, pimento, and cloves, of each 1 drm.; rum, at proof, 2½ gal.; digest as before, distill over 2 gal., and add clarified sirup, 1 gal. If wanted weaker, lower with clear soft water.

Crême des Barbades.—Essence of cedrat, distilled, 6 gr.; essence of Portugal, distilled, 3 gr.; essence of cinnamon, 0·40 gr.; essence of cloves, 0·40 gr.; essence of nutmeg, 0·20 gr.

Bead for Liquors.—Oil of vitriol, 2 oz.; sweet oil, 1 oz.; mixed in a glass bottle. One drop for 1 qt. of liquor.

Benedictine.—Cloves, 2 gr.; nutmegs, 2 gr.; cinnamon, 3 gr.; balm, peppermint, freshly gathered angelica and genepi of the Alps, 25 gr.; calamus, 15 gr., cardamom (small), 50 gr.; arnica flowers, 8 gr. Break and crush the materials and macerate for 2 days in 4 l. of alcohol at 85°. Distill after having added 3 l. of water and draw out 4 l., after which add a cold sirup made with 4 k. of sugar and 2 l. of water. Bring up to 10 l., color, and filter.

Bitters.—These have generally from 1 to 1½ lb. of sugar per gal.

Brandy.—Barrels, to give the Appearance of Age to.—Dissolve in 3 gal. water, 3 lb. sulphuric acid and 1 lb. sulphate of iron. Wash the barrels with it on the outside.

Apple, Imitation.—Forty gal. cologne spirit, 4 oz. apple brandy oil, cut in 1 pt. alcohol, 88%; 6 oz. D. R. glycerine; ½ gal. sugar sirup. No coloring.

Blackberry.—Forty gal. cologne spirit, 6 oz. blackberry oil, 2 gal. blackberry or cherry juice, ½ pt. ext. blackberry, and 4 oz. sugar coloring, to color.

Brandy, British.—*Syn.* Malt Brandy.—For a long time this liquor was distilled from spoiled wine and the dregs of wine, both British and foreign, mixed with beer bottoms, spoiled raisins, and similar substances. At the present day, spirit made from malt, potatoes, beet root and carrot is employed. Malt spirit is the best adapted for the manufacture of British brandy.

We annex formulas:

1. To 12 gal. of malt spirit at proof, add of water, 5 gal.; crude red tartar or winestone, previously dissolved in 1 gal. of boiling water, ¾ lb.; acetic ether, 6 fl. oz.; French wine vinegar, 2 qt.; French plums, bruised, 5 lb.; sherry bottoms, ½ gal.; mix these ingredients in a sherry or French brandy cask, and let them stand for about a month, frequently stirring the liquid with a stick; next draw over 15 gal. of the mixture from a still furnished with an agitator. Put the distilled spirit into a clean, fresh emptied cognac brandy cask, and add of tincture of catechu, 1 pt.; oak shavings, 1 lb.; and spirit coloring, ½ pt.; agitate occasionally for a few days, and then let it repose for a week, when it will be fit for use. This produces 15 gal. of brandy, 17 u. p. Age greatly improves it.

2. Malt spirit, 99 gal.; red tartar dissolved in water, 7 lb.; acetic ether, ½ gal.; wine vinegar, 5 gal.; bruised raisins or French plums, 14 lb.; bitter almond cake bruised and steeped for twenty-four hours in twice its weight of water, which must be used with it, ¼ lb.; water, q. s.; macerate as before, and draw over, with a quick fire, 120 gal. To the distilled spirit add a few lb. of oak shavings, 2 lb. of powdered catechu made into a paste with hot water, and spirit coloring, q. s., and finish as in the last. Produces 120 gal. of spirit, fully 17 u. p. Equal in quality to the last.

3. Clean spirit, 17 u. p., 100 gal.; nitrous ether, 2 qt.; ground cassia buds, 4 oz.; bitter almond meal, 5 oz.; sliced orris root, 6 oz. cloves, in powder, 1 oz.; capsicum, 1½ oz.; good vinegar, 3 gal.; brandy coloring, 3 pt.; powdered catechu, 2 lb.; full flavored Jamaica rum, 2 gal. Mix in an empty cognac piece, and macerate for a fortnight, with occasional stirring. Produces 106 gal., at 21 or 22 u. p.

4. Malt spirit, 17 u. p., 100 gal.; catechu, 2 lb.; tincture of vanilla, ½ pt.; burnt sugar coloring, 1 qt.; good rum, 3 gal.; acetic or nitrous ether, 2 qt. Mix as the last.

5. Clean spirit, 17 u. p., 89 gal.; highly flavored cognac, 10 gal.; oil of cassia, 2 drm.; oil of bitter almonds, 3 drm.; catechu, in powder, 1 lb.; cream of tartar, previously dissolved in water, 1¼ lb.; concentrated acetic acid, ½ gal.; sugar coloring, 2 to 3 pt.; good rum, 1 gal.

To those of the above mixtures which are submitted to distillation, the French brandy coloring substance and catechu must be added after, not before, distillation.

California.—Forty gal. cologne spirit; 4 oz. husk essence; ¼ ounce light oil of vine; ½ pallargonic ether; 3 lb. wine sirup. Color with French brandy coloring.

Brandy, Caraway.—A species of cordial commonly prepared as follows: 1. Bruised caraway seeds, 4 oz.; lump sugar, 2 lb.; British brandy, 1 gal.; macerate a fortnight, occasionally shaking the bottle.

2. Sugar, 1 lb.; bruised caraways, 1 oz.; 3 bitter almonds, grated; spirit coloring, 1 oz.; plain spirit or gin, 22 u. p., ½ gal. Infuse, etc., as balm of Molucca. The coloring is sometimes left out.

Catawba.—Forty gal. cologne spirit; 6 oz. catawba brandy oil, and 2 lb. wine sirup cut in 1 qt. alcohol, 88%. Color with French brandy coloring.

Cherry.—Forty gal. cologne spirit; 6 oz. cherry brandy oil cut in 1 pt. alcohol, 88%; 2 gal. cherry juice; 1 qt. sugar sirup; 1 pt. cherry extract, and 4 oz. sugar coloring, to color.

Brandy, Cherry.—1. Brandy and cherries crushed, of each 1 gal.; let them lie together for 3 days, then express the liquid and add 2 lb. lump sugar; in a week or two decant the clear portion for use.

2. To the last add 1 qt. raspberry juice, and ½ pt. orange flower water. Both the above are excellent.

3. Molasses, 1 cwt.; spirit, 45 u. p., 41 gal.; bitter almonds bruised, 1 lb., more or less to taste; cloves, 1 oz.; cassia, 2 oz.; macerate a month, frequently stirring. An article frequently sold as cherry brandy.

4. German cherry juice, 15 gal.; pure rect. spirit, 20 gal.; sirup, 5 gal.; oil of bitter almonds, 1 drm.

5. Mash 8 lb. black cherries, without being stoned, 10 qt. 95% alcohol. Macerate for 2 weeks; press; add 5 lb. sugar dissolved in 2 gal. brandy.

Brandy, Cider.—From cider and perry; also from the marc of apples and pears fermented. It is very largely manufactured in the United States and Canada.

Brandy, Dantzic.—From rye, ground with the root of *Calamus aromaticus*. It has a mixed flavor of orris and cinnamon.

Ginger.—Forty gal. cologne spirits; 1½ lb. ginger brandy oil; ½ gal. sugar sirup; 6 oz. sugar coloring.

Brandy, Lemon.—1. Fresh lemons, sliced, 1 doz.; brandy, 1 gal.; macerate for a week, press out the liquid, and add of lump sugar, 1 lb.

2. Proof spirit, 7 gal.; essence of lemon, 3 drm.; sugar, 5 lb.; tartaric acid, 1 oz.; dissolved in water; 2 gal. turmeric powder; of spirit coloring, a dessertspoonful; macerate, etc., as No. 1. Sometimes boiling milk is added to the above, in the proportion of 1 qt. to every gal.

Brandy, Malt.—Malt spirit, flavored with sweet spirits of niter and terra japonica, and colored with molasses, or spirit coloring.—See Brit. Brandy.

New York Brandy.—Forty gal. cologne spirit or good rectified spirits; 2 oz. New York brandy essence, 1 oz. prussic ether, dissolved in 1 pt. alcohol, 88%. To improve, add 1½ pt. sugar sirup. Color with sugar coloring.

Orange Brandy.—To every ½ gal. of brandy allow ¾ pt. of Seville orange juice, 1¼ lb. loaf sugar. To bring out the full flavor of the orange peel, rub a few lumps of the sugar on 2 or 3 unpared oranges, and put these lumps to the rest. Mix the brandy with the orange juice, strained, the rinds of six of the oranges, pared very thin, and the sugar. Let all stand in a closely covered jar for about three days, stirring it three or four times a day. When clear it should be bottled and close corked for a year; it will then be ready for use, but will keep any length of time. This is a most excellent stomachic when taken pure in small quantities; or, as the strength of the brandy is very little deteriorated by the other ingredients, it may be diluted with water. To be stirred every day for three days. Sufficient to make 2 qts.; make this in March.

Brandy, Orange.—As lemon brandy, but substituting oranges.

Brandy, Pale.—This article has been already referred to. That of the ginshops and publicans is generally a spurious article, made by mixing together about equal parts of good brown French brandy, clean alcohol and soft water, and allowing the whole to stand until the next day to fine down.

Brandy, Patent.—This is merely very clean malt spirit mixed with about one-seventh or less of its bulk of strongly flavored cognac and a little coloring.

Brandy, Peach.—From peaches, by fermentation and distillation. Much used in the United States. A cordial spirit under the same name is prepared as follows:

1. From peaches, sliced and steeped in twice their weight of British brandy or malt spirit, as in making cherry brandy.

2. Bitter almonds bruised, 3 oz.; proof spirit, 10 gal.; water, 3 gal.; sugar, 5 or 6 lb.; orange flower water, ½ pt.; macerate for fourteen days. Add brandy coloring, if required darker.

3. Dissolve 1 gal. of honey in water, add 7 gal. of alcohol, 1 gal. rum, 2 oz. of catechu bruised, 2 oz. acetic ether; add ½ lb. of bitter almonds; dissolved, 20 gal. water.

4. Peach.—Forty gal. cologne spirit; ¼ lb. peach brandy oil; 6 oz. glycerine; ½ gill sugar sirup. No coloring.

Raspberry.—1. Pour as much brandy over raspberries as will just cover them; let it stand for twenty-four hours, then drain it off and replace it with a like quantity of fresh spirit; after twenty-four hours more, drain this off and replace it with water; lastly, drain well and press the raspberries quite dry. Next add sugar to the mixed liquors, in the proportion of 2 lb. to every gal., along with ¼ pt. of orange flower water.

2. Mix equal parts of mashed raspberries and brandy together, let them stand twenty-four hours, then press out the liquor. Sweeten as above and add a little cinnamon and cloves, if agreeable; lastly, strain.

3. From raspberries, using the proportion given under cherry brandy. Sometimes a little cinnamon and cloves are added. The only addition, however, that really improves the flavor or bouquet is a little orange flower; water, a very little essence of vanilla, or a single drop of essence of ambergris.

Brandy, Shrub.—Brandy, 1 gal.; orange and lemon juice, of each 1 pt.; the peel of 2 oranges; do. of 1 lemon; digest for twenty-four hours, strain and add of white sugar, 4 lb., dissolved in water, 5 pts. After a fortnight decant the clear liquid for use.

Caraway Cordial.—This is generally made from the essential oil of caraway, with 2½ lb. of sugar per gal. One fl. drm of the oil is commonly reckoned equal to ¼ lb. of the seed. The addition of a very little oil of cassia and about half as much of essence of lemon or of orange improves it.

Crême de Cassis.—Infusion of currants, 4·20 l.; spirit of raspberries, 0·50 l.; alcohol, at 85°, 0·60 l.; white sugar, 5 k.; water, 1·60 l.

Crême de Céleri.—Essence of celery, 2 gr.; alcohol, 3·10 l.; water, 3·90 l.; sugar, 4·375 k.

Cedrat Cordial.—From essence (oil) of cedrat, ¼ oz.; pure spirit (at proof), 1 gal.; dissolve, add of water, 3 pt., agitate well; distill 3 qt., and add an equal measure of clarified sirup. A delicious liqueur. See *Crême* and *Eau*, further on.

Chartreuse.

Ingredients.	Green.	Yellow.	White.
China cinnamon.....	1·50 gr.	1·50 gr.	12·50 gr.
Mace..........	1·50 gr.	1·50 gr.	3 gr.
Lemon balm, dried..	50 gr.	25 gr.	25 gr.
Hyssop in flower, tops..........	25 gr.	12·50 gr.	13·50 gr.
Peppermint, dried...	25 gr.	....	....
Thyme..........	3 gr.	....	....
Balsine (bal. major),	12·50 gr.	....	....
Genepi	25 gr.	12·50 gr.	12·50 gr.
Arnica, flowers of...	1 gr.	1·50 gr.	....
Balsam poplar, buds.	1·50 gr.	....	....
Angelica, seeds......	12·50 gr.	12·50 gr.	12·50 gr.
Angelica, roots	6·25 gr.	3 gr.	3 gr.
Coriander..........	....	150 gr.	....
Cloves	....	1·50 gr.	3 gr.
Aloes, socotrine.....	....	3 gr.	....
Cardamom, small....	....	5 gr.	3 gr.
Nutmegs..........	....	....	1·50 gr.
Calamus	....	....	30 gr.
Tonka beans..........	....	....	1·50 gr.
Alcohol, at 85°.......	6·25 l.	4·25 l.	5·25 l.
White sugar..........	2·50 k.	2·50 k.	3·75 k.

Digest in alcohol for twenty-four hours. Distill so as to obtain, nearly all the spirit. Repeat the operation, if necessary, or add water to make 10 l. Color, and after reposing, filter.—*H.*

Chartreuse, by Essences.—Essence of lemon balm, 0·20 gr.; essence of hyssop, 0·20 gr.; essence of Angelica, 1 gr.; essence of English mint, 2 gr.; essence of Chinese cinnamon, 0·20 gr.; essence of cloves, 0·20 gr.; essence of nutmegs, 0·20 gr. Color yellow or green. Alcohol (85°), 3 l.; sugar, 5·6 k.; water, 2·6 l.; for 10 l.

Grande Chartreuse.—This renowned liqueur, made by the monks of the Monastery of the Grande Chartreuse, near Grenoble, is said to have the following composition; Essence of balm (flavored with lemon), 31 grn.; essence of hyssop, 31 grn.; essence of angelica, 2½ drm.; essence of English peppermint, 5 drm.; essence of nutmeg, 36 grn.; essence of cloves, 31 grn.; rectified alcohol, 3⅓ pt.; sugar, q. s.; the whole being colored yellow or green, according to taste. Another writer states that it is composed of carnations, wormwood and the young buds of the pine tree, and that there are three kinds—white, yellow and green, each differing in strength.

Cherry Cordial.—Mix 2¼ lb. cherry juice with 1½ qt. alcohol, 80%. Add 8 drops oil of cloves, ½ lb. sugar, 1¾ qt. water. Filter.

Cinnamon Cordial.—1. Proof spirits, 9 gal.; essential oil of cinnamon (cut in 1½ qt. alcohol), 3 drm.; clear soft water, 4½ gal.; simple sirup, 2⅝ gal. Agitate thoroughly and color if desired.

2. This is seldom made with cinnamon, owing to its high price, but either with the essential oil or bark of cassia, with about 2 lb. of sugar to the gal. It is preferred colored, and therefore may be very well prepared by simple digestion. The addition of 5 or 6 drops each of essence of lemon and orange peel, with about a spoonful of essence of cardamoms per gal., improves it. One oz. oil of cinnamon is considered equal to 8 lb. of the buds or bark. One fl. drm. of the oil is enough for 2½ gal. It is colored with burnt sugar.

Cordial, Citron.—1. Yellow rind of citron, 3 lb.; orange peel, 1 lb.; nutmegs bruised, 2 oz.; proof spirit, 13 gal.; distill or macerate, add water sufficient and 2 lb. of fine lump sugar for every gallon of the cordial.

2. From the oil or peel, with 3 lb. of sugar per gal., as above.

3. Rinds of yellow citrons, 3 lb.; orange peel, ¾ lb.; bruised nutmegs, 1½ oz.; proof spirits, 9 gal. Digest for twelve days, filter and add clear soft water, 4½ gal.; simple sirup, 2⅝ gal. Agitate. Color if desired.

Citronelle.—*Syn.* Eau de Barbades.—1. From fresh orange peel, 2 oz.; fresh lemon peel, 4 oz.; cloves, ½ drm.; corianders and cinnamon, of each 1 drm.; proof spirit, 4 pt.; digest for ten days; then add of water, 1 qt., and distill ½ gal.; to the distilled essence add of white sugar, 2 lb.; dissolved in water, 1 qt.

2. Essence of orange, ½ drm.; essence of lemon, 1 drm.; oil of cloves and cassia, of each 10 drops; oil of coriander, 20 drops; spirit, 58 o. p., 5 pt.; agitate till dissolved, then add of distilled or clear soft water, 3 pt.; well mix, and filter it through blotting paper, if necessary. Lastly, add of sugar dissolved in water, q. s.

Clairet.—Rossolis des Six Graines.—1. From aniseed, fennel seed, coriander seed, caraway seed, dill seed and seeds of the candy carrot *Athamantia cretensis* (Linn.), of each bruised, 1 oz.; proof spirit, ½ gal.; digest for a week, strain, and add of loaf sugar, 1 lb., dissolved in water, q. s.

2. *Eau-Clairette.*—Another very old French form was, 3 oz. cinnamon, eau de vie, 1 pt., to which was added sugar and rose water.

Cordial, Clove.—1. Bruised cloves, 1 oz., or essential oil, 1 drm., to every 4 gal. proof spirit. If distilled it should be drawn over with a pretty quick fire. It is preferred of a very deep color, and is therefore strongly colored with poppy flowers or cochineal, or more commonly with brandy coloring, or red sanders wood. It should have 3 lb. of sugar to the gal., and this need not be very fine. The addition of 1 drm. of bruised pimento, or 5 drops of the oil for every oz. of cloves improves this cordial.

2. Proof spirits, 9 gal.; essential oil of cloves (cut in alcohol), 1½ drm.; clear soft water, 4½ gal.; simple sirup, 3 gal. Color dark with sugar coloring. Agitate thoroughly.

Coffee Liqueur:

Ground roasted coffee	112 parts.
Diluted spirit	450 parts.

Digest, express and filter. To 300 parts of the filtered liquid add—

Tincture of vanilla	5 parts.
Diluted spirit	155 parts.
Simple sirup	225 parts.

—*Pharm. Zeit.*

Cognac.—Forty gal. good spirits, distilled or rectified; 6 oz. œnanthic ether; 1 oz. cognac brandy oil, dissolved in 1 qt. alcohol, 88%; 1½ lb. wine sirup. Color with sugar coloring.

Coloring for Liqueurs.—Red: Cudbear, 400 gr.; alcohol, 85° 1 l. Macerate for five days, stirring frequently. Decant the liquid, treat the residue in the same manner, unite the two liquids and filter.

Yellow Color.—Saffron, 100 gr.; water, 1·5 l. Boil half the water and pour on the saffron. Cover tightly and macerate until the infusion is cold. Repeat the operation on the residue and mix the two liquids. Add 750 c. c. of alcohol at 85° and filter.

Best white crushed or lump sugar, 6 lb.; water, ¾ pt. Boil until black. Remove from the fire, cool with water, stirring as the water is added. Used to color liquors from a light amber to a dark brown. For brandy, whisky, old rye, etc.

Red Color.—Beet root, red sanders, or cochineal.

Port Wine Color.—Extract of rhatany.

The substances employed in France to color liqueurs are, for—

Blue.—Sulphate of indigo, nearly neutralized with chalk and the juice of blue flowers and berries.

Amber, Fawn and Brandy Color.—Burnt sugar or spirit coloring.

Green.—Spinach or parsley leaves digested in spirit and mixtures of blue and yellow.

Red.—Powdered cochineal or Brazil wood, either alone or mixed with a little alum.

Violet.—Blue violet petals, litmus, or extract of logwood.

Purple.—The same as violet, only deeper.

Yellow.—An aqueous infusion of safflower or French berries and the tinctures of saffron and turmeric.

Cordial.—Aromatized and sweetened spirit, employed as a beverage. Cordials are prepared by either infusing the aromatics in the spirit and drawing off the essence by distillation, which is then sweetened, or without distillation, by flavoring the spirit with essential oils, or simple digestion on the ingredients, adding sugar or sirup as before. Malt or molasses spirit is the kind usually employed, and for this purpose should be perfectly flavorless, as, if this be not the case, the quality of the cordial will be inferior. Rectified spirit of wine is generally the most free from flavor, and when reduced to a proper strength with water, forms the best and purest spirit for cordial liquors.

Coriander Cordial.—From coriander seeds, as *Cloves.* A few sliced oranges improve it.

Crème d'Anis.—As *Aniseed* cordial, only richer.

Crème des Barbades.—As *Citronelle*, adding some of the juice of the oranges and an additional pound of sugar per gallon.

Crème de Cacao.—Infuse roasted Carac's nuts cut small, 1 lb., and vanilla, ⅛ oz., in brandy, 1 gal., for eight days; strain and add of thick sirup 3 qt.

Crème de Cedrat.—Huile de Cedrat. From spirit of citron, 1 pt.; spirit of cedrat, 1 qt.; proof spirit, 3 qt; white sugar, 16 lb.; dissolved in pure soft water, 2 gal.

Crème de Genépi des Alpes.—Génépi in flower, 200 gr.; peppermint flowers, 100 gr.; balsam, 100 gr.; angelica root, 50 gr.; galanga, 12·5 gr.; alcohol at 85°, 4·25 l., white sugar, 3·75 k. General method, color green. Product 10 liters.

Crème de Macarons.—1. From cloves, cinnamon and mace, of each, bruised, 1 drm.; bitter almonds, blanched and beaten to a paste, 7 oz.; spirit, 17 u. p., 1 gal.; digest a week, filter and add of white sugar, 6 lb., dissolved in pure water, 2 qt.

2. Clean spirit, at 24 u. p., sp. gr. 0·945, 2 gal.; bitter almonds, ¾ lb.; cloves, cinnamon and mace, of each in coarse powder, 1½ drm., infuse for ten days, filter, and add of white sugar, 8 lb., dissolved in pure water, 1 gal.; lastly, give the liqueur a violet tint with infusion or tincture of litmus and cochineal. An agreeable, nutty flavored cordial, but, from containing so many bitter almonds, should only be drunk in small quantities at a time. The English use only one-half the above quantity of almonds.

Crème de Naphe.—From sweetened spirit 60 u. p., containing 3½ lb. of sugar per gal., 7 qt.; foreign orange flower water, 1 qt. Very delicious.

Crème de Noyeau. See *Noyeau.*

Crème d'Orange.—From sliced oranges, 3 dozen; rectified spirit, 2 gal.; digest for fourteen days; add, of lump sugar, 28 lb., previously dissolved in water, 4½ gal.; tincture of saffron, 1½ fl. oz.; and orange flower water, 2 qt.

Crème de Portugal.—Flavored with lemon, to which a little oil of bitter almonds is added.

Curaçoa.—From sweetened spirit, at 56 u. p., containing 3½ lb. of sugar per gal., flavored with a tincture made by digesting the oleosaccharum prepared from Seville oranges, nine in number; cinnamon, 1 drm.; and mace, ¾ drm. in rectified spirit, 1 pt. It is colored by digesting in it for a week or ten days, Brazil wood in powder, 1 oz; and afterward mellowing the color with burnt sugar, q. s.

Curaçoa (by Essences).—Essence of curaçoa, distilled, 7 gr.; essence of Portugal, 2·50 gr.; essence of cloves, 5 gr. Bitter infusion of curaçoa, q. s.; alcohol, 3·10 l.; water, 3·90 l.; sugar, 4·375 k.

Delight of the Mandarins.—From spirit, 22 u.

p., 1 gal.; pure soft water, ½ gal.; white sugar crushed small, 4½ lb.; Chinese aniseed and ambrette or musk seed, of each, bruised, ½ oz.; safflower, ¼ oz.; digested together in a carboy or stone bottle capable of holding double, and agitated well every day for a fortnight.

Eau de Cedrat.—Syn. cedrat water. As crême de cedrat, but using less sugar.

Eau de Chasseurs. See *Peppermint.*

Eau de Vie d'Andaye. Syn. Eau de vie d'anis; aniseed liqueur brandy; liqueur d'hendaye. From brandy or proof spirit, 1 gal.; sugar, ¾ lb.; dissolved in aniseed water, 1 pt. This is sometimes flavored with fennel.

Eau d'or Liqueur.—Put in a jar 1 oz. of coriander seeds, ½ oz. of cinnamon, ½ oz. of cloves, 1 qt. of spirit of wine registering 80° by Gay Lussac's alcoholometer. Let the spices steep for twenty-four hours, then add 3 gills of sirup registering 24° on the saccharometer and filter the whole three times through a felt filtering bag; add 2 sheets of gold leaf to the liqueur; shake it to divide the gold and bottle it.

Eau de Vie de Dantzick (by Essences).—Essence Ceylon cinnamon, 40 grn.; essence China cinnamon, 1·20 grn.; essence of coriander, 0·20 grn.; essence of lemon (distilled), 0·80 grn.; alcohol, etc., the same as curaçoa.

Eau de Vie de Dantzick.—Ceylon cinnamon, 25 grn.; cloves, 15 grn.; green anise, 12·5 grn.; celery seeds, 12·5 grn.; caraway seeds, 12·5 grn.; cumin seeds, 3 grn.; alcohol at 85°, 5 l.; white sugar, 2·5 k. General method without rectification. Product, 10 l.

Fining for Cordials (Eggs).—Take the white of an egg with each 5 gal. of the cordial, beat up with alcohol and add gradually to the cordial.

Fining with Potash. For each 10 gal. of the cordial add 1 oz. of potassium carbonate dissolved in 1 pt. of water, add gradually.

Gin.—1. Clean corn spirit, at proof, 80 gal.; newly rectified oil of turpentine, 1 pt.; mix well by violent agitation, add culinary salt, 7 or 8 lb., dissolved in water, 30 or 40 gal.; again well agitate and distill over 100 gal., or until the feints begin to rise. Product—100 gal., 22 u. p., besides 2 gal. contained in the feints. If 100 gal., 17 u. p., be required, 85 gal. of proof spirit, or its equivalent at any other strength, should be employed.

2. Proof spirit, as above, 8 gal.; oil of turpentine, 1 to 1½ oz.; salt, 1 lb., dissolved in water, 3 or 4 gal.; draw 10 gal., as before. 22 u. p.

3. Clean corn spirit, 80 gal.; oil of turpentine, ¾ to 1 pt.; pure oil of juniper, 1 oz. to 3 oz.; salt, 7 lb., water, 35 gal., draw 100 gal. as above. 22 u. p.

4. To the last add oil of caraway, ½ oz., oil of sweet fennel, ¼ oz., distill as before.

5. To No. 3 add essential oil of almonds, 1 drm., or less; essence of lemon, 3 or 4 drm.; distill as before.

6. To No. 1 add creosote, 1 to 2 drm., before distillation.

7. To No. 3 add creosote, 1 to 2 drm., before distillation.

8. Proof spirit, 80 gal.; oil of turpentine, ½ pt.; oil of juniper, 3 oz.; creosote, 2 drm.; oranges and lemons, sliced, of each 9 in number, macerate for a week, and distill 100 gal. 22 u. p.

The oil of turpentine for this purpose should be of the best quality, and not that usually vended for painting, which contains resin and fixed oil. Juniper berries, bitter almonds, and the aromatic seeds, may be used instead of the essential oils; but the latter are most convenient. Turpentine conveys a plain gin flavor, creosote imparts a certain degree of smokiness, lemon and other aromatics a creaminess, fullness, and richness. Gin may also be prepared by simple solution of the flavoring in the spirit, but is of course better for distillation.

Sweetened gin is made from unsweetened gin, 22 u. p., 95 gal.; lump sugar, 40 to 45 lb., dissolved in clear water, 3 gal.; mix well, and fine it down as above. Produces 100 gal., at 26 u. p. This, as well as the last, is usually permitted at 22 or 24 u. p., which is also done when the gin has been further lowered with water so to be even 30 or 35 u. p.—*Brewer and Distiller.*

Gold Cordial.—From angelica root, sliced, 1 lb.; raisins, ½ lb.; coriander seeds, 2 oz.; caraway seeds and cassia, of each 1½ oz.; cloves, ½ oz.; figs and sliced licorice root, of each 4 oz.; proof spirit, 3 gal.; water, 1 gal.; digest 2 days, and distill 3 gal. by a gentle heat; to this add, of sugar, 9 lb., dissolved in rose water and clean soft water, of each 1 qt.; lastly, color the liquid by steeping in it 1¼ oz. of hay saffron. This cordial was once held in much esteem for its supposed medicinal virtues, the formula being mentioned by Arnold de Villeneuve. It derives its name from a small quantity of gold leaf being formerly added to it, which was supposed to add greatly to its remedial value. Until comparatively recent years, gold was credited with extraordinary remedial powers.

Cordial, Gout.—Rhubarb, senna, coriander seed, sweet fennel seed, and cochineal, of each 2 oz.; licorice root and saffron, of each 1 oz.; raisins, 2½ lb.; rectified 90% alcohol, 2 gal.; digest for fourteen days. Used in gout and rheumatism.

Hollands.—Geneva, Schiedam, Hollands Gin, Dutch Gin.—1. The materials employed in the distilleries of Schiedam, in the preparation of this excellent spirit, are 2 parts of the best unmalted rye and 1 part of malted bigg, reduced to the state of course meal by grinding. About a barrel (36 gal.) of water, at a temperature of from 162° to 168° Fah., is put into the mash tun for every 1½ cwt. of meal, after which the malt is introduced and stirred, and lastly, the rye is added. Powerful agitation is next given to the magma till it becomes quite uniform, when the mash tun is covered over with canvas, and left in this state for two hours. Agitation is then again had recourse to, and the transparent spent wash of a preceding mashing is added, followed by as much cold water as will reduce the temperature of the whole to about 85° Fah. The gravity of the wort at this point varies from 33 to 38 lb. A quantity of the best pressed Flanders yeast, equal to 1 lb. for every 100 gal. of the mashed materials, is next stirred in, and the whole is fermented in the mash tun for about three days, or until the attenuation is from 7 to 4 lb. (sp. gr. 1·007 to 1·004). During this time the yeast is occasionally skimmed off the fermenting wort. The wash, with the grains, is then transferred to the still, and converted into low wines. To every 100 gal. of this liquid, 2 lb. of juniper berries (three to five years old), and about 1 lb. of salt, are added, and the whole is put into the low wine still, and the fine spirit drawn off by a gentle heat, one receiver only being employed. The product

per quarter varies from 18 to 21 gal. of spirit, 2 to 3 o. p.

2. Best Hollands.—Hollands rectified to the strength of 24° Baume (sp. gr. 0·9125, or about 6 o. p.).

3. Dr. Thompson gives the following formula for preparing gin, Geneva or Hollands. He states it is one used by the Dutch manufacturers: One hundred and twelve lb. of barley malt and 228 lb. of rye meal are mashed with 460 gal. of water, at 162° Fah. After infusing a sufficient time, cold water is added until the gravity of the wort is reduced to 45 lb. per barrel. The whole is let into a fermenting back at 80° Fah., ½ a gal. yeast is added, the temperature rises to 90°, and the fermentation is over in forty-eight hours. The wash is attenuated until the specific gravity is about 12 or 15 lb. per barrel. Both the wash and grains are then put into the still; the low wines are distilled off, these are redistilled, and the production is rectified. A few juniper berries and some hops are used to communicate a peculiar flavor to the spirit.

4. English made.—From juniper berries (at least a year old and crushed in the hands), 3 lb.; rectified spirit, 1½ gal. (or proof spirit, 2½ gal.); digest, with agitation, for a week, and then express the liquid; after twenty-four hours' repose, decant the clear portion, add it to good corn spirit, at 2 or 3% over proof, 90 or 100 gal.; and mix them well together.

5. From juniper berries, 2½ lb.; sweet fennel seed, 5 oz.; caraway seeds, 3½ oz.; proof spirit, 2 gal., corn spirit, 90 or 100 gal.

6. As the last, with the addition of Strasburg turpentine or Canadian balsam, 1 lb.—*Brewer and Distiller.*

Huile d'Anis. See *Crème d'Anis.*

Huile d'Ananas.—Five oz. rasped pineapple are macerated in 15 oz. 90% alcohol for fifteen or twenty days, at the end of which time the liquid is decanted and filtered. It is then well shaken up with 15 oz., by weight, of clear sirup.

Huile Liquoreuse.—1. De la Rose. From eau de rose, 1 part; simple sirup, 2 parts; mixed together.

2. Des Fleurs d'Orange.—From orange flower water and sirup, as No. 1.

3. De Vanille.—From essence of vanilla, 1 drm.; simple sirup, 1 pt.

The above are kept in small decanters, and used to flavor water, grog, liqueurs, etc., instead of sugar or capillaire; also to perfume the breath. Other flavored sirups, for the same purpose, are prepared in a similar manner.

Huile de Vanille.—Flavored with essence or tincture of vanilla. It is kept in a decanter, and used to flavor liqueurs, grog, etc.

Huile de Vénus.—From the flowers of the wild carrot, 2½ oz., and sugar, 3 lb. to the gal. It is generally colored by infusing a little powdered cochineal in it.

Liqueur Hygienique de Dessert (formula Raspail).—Alcohol at 56°, 0·10 l.; angelica root, 3 gr.; calamus, 0·20 l.; myrrh, 0·20 gr.; cinnamon, 0·20; aloes, 0·20 gr.; cloves, 0·10 gr.; vanilla, 0·10 gr.; camphor, 0·050 gr.; white nutmegs, 0·025 gr.; saffron, 0·005 gr. The whole mixture is allowed to digest for several days in the sun in a well corked bottle.

Jargonelle.—*Syn.* Jargonelle Cordial. Flavored with essence of jargonelle pear (acetate of amyl). Pineapple cordial and liqueurs from some other fruits are also prepared from the artificial fruit essences.

Kirschwasser.—A spirituous liquid distilled in Germany and Switzerland from bruised cherries. From the rude manner in which it is obtained, and from the distillation of the cherry stones (which contain prussic acid) with the liquid, it has often a nauseous taste, and is frequently poisonous. When properly made and sweetened it resembles noyeau.

Huile de Kirschenwasser.—Essence of noyaux, 4 gr.; essence of neroli (Paris), 0·40 gr.

Lemon Cordial.—Digest fresh and dried lemon peel, of each 2 oz., and fresh orange peel, 1 oz., in proof spirit, 1 gal., for a week; strain with expression, add of clear soft water q. s. to reduce it to the desired strength and lump sugar, 3 lb. to the gal. The addition of a little orange flower or rose water improves it.

Jessamine Liqueur.—Pick ¼ lb. of Jessamine blossoms, and put them in a jar with 2 qt. of 90% alcohol, registering 50° by Gay Lussac's alcoholometer; let the blossoms steep for two days; prepare 1½ pt. of clarified sirup registering 30 on the saccharometer. Strain the jessamine spirit, mix it with the cold sirup and filter it, with some paper, through a filtering bag. Continue pouring the liqueur through and through until it is quite clear, and bottle it for use.

Lemon Cordial.—Digest 2 oz. each of fresh and dried lemon peel and 1 oz. of fresh orange peel in 1 gal. of proof spirit for a week; strain with expression, add clear soft water to reduce it to the desired strength, and lump sugar, in the proportion of 2½ lb. to 3 lb. to the gal. The addition of a little orange flower or rose water improves it.

Essence of Lemon.—The rinds of 80 fresh lemons; alcohol at 85°, 12 l. Process the same as cedrat.

Essence of Lemon, Concentrated.—Rinds of 160 fresh lemons; alcohol, same as above. Process same as cedrat.

Liqueurs.—Dilute alcohol, aromatized and sweetened. The French liqueurists are proverbial for the superior quality, creamlike smoothness and delicate flavor of their cordials.

Liquodilla.—Flavored with oranges and lemons, of each, sliced, 3 in number; with sugar 2½ lb. per gal.

Lovage Cordial.—From the fresh roots of lovage, 1 oz. to the gal. A fourth of this quantity of the fresh roots of celery and sweet fennel are also commonly added. In some parts a little fresh valerian root and oil of savine are added before distillation. This cordial is much valued by the lower classes in some of the provinces for its stomachic and emmenagogue qualities.

Maraschino (Marasequin).—A delicate liqueur spirit distilled from a peculiar cherry growing in Dalmatia, and afterward sweetened with sugar. The best is from Zara, and is obtained from the marasca cherry only. In the middle of the last century the profits arising from the sale of this compound were so considerable that the Senate of Venice, where it was principally manufactured, monopolized the trade in it. An inferior quality is distilled from a mixture of cherries and the juice of licorice root.

Maraschino (Zara), Imitation.—Essence of

noyaux, 3·5 gr.; essence of neroli, 0·50 gr.; extract of jasmine, 1 grn.; extract of vanilla, 1·50 gr.

Marasquin de Zara.—Essence of noyaux, 3·5 gr.; essence of neroli, 0·5 gr.; extract of jasmine, 1 gr.; extract of vanilla, 1·5 gr.; alcohol, etc., same as for chartreuse.

Crême de Millefleurs.—Essence of neroli, 5 gr.; essence of roses, 20 gr.; extract of jasmine, 2 gr.; extract of jonquil, 1·5 gr.; extract of reseda, 2 gr.; extract of tuberose, 2 gr.; alcohol, etc., same as for chartreuse.

Mint Liqueur (Crême de Menthe).—Put 2 oz. of green mint into a jar, pour over 1 qt. of 90% alcohol, registering 50° by Gay Lussac's alcoholometer, and let it steep for eight days; add 3 gills of sirup registering 30° on the saccharometer, mix it with some filtering paper and pour the whole into a filtering bag. When the liqueur is thus strained it should be perfectly clear and limpid; bottle it and keep the bottles in a dry place.

Mint Cordial.—Oil of peppermint, ¼ oz.; sirup, 2½ pt.; rectified spirits, 5 pt.; alcohol, ½ pt. Color light green.

Nectar.—The fabled drink of the mythological deities. The name was formerly given to wine dulcified with honey; it is now occasionally applied to other sweet and pleasant beverages of a stimulating character. The following liqueur is so called: Chopped raisins, 2 lb.; loaf sugar, 4 lb.; boiling water, 2 gal.; mix and stir frequently until cold, then add 2 lemons, sliced; proof spirit, brandy or rum, 3 pt.; macerate in a covered vessel for six or seven days, occasionally shaking; next strain with pressure, and let the strained liquid stand in a cold place for a week to clear; lastly, decant the clear portion and bottle it.

Noyau.—Crême de Noyou.—This is a pleasant nutty-tasted liquor; but, from the large proportion of prussic acid which it contains, it should be partaken of very moderately.

1. Bitter almonds, bruised, 3 oz.; spirit, 22 u. p., 1 qt.; sugar, 1 lb. dissolved in water, ¾ pt.; macerate for 10 days, frequently shaking the vessel; then allow it to repose for a few days, and decant the clear portion.

2. As the last, but substituting apricot or peach kernels with the bruised shells for the almonds.

3. To either of the above, add of coriander seed and ginger, of each, bruised, 1 drm.; mace and cinnamon, of each ½ drm.

4. Crême de Noyau de Martinique.—Loaf sugar, 24 lb.; water 2½ gal.; dissolve, add, of proof spirit, 5 gal.; orange flower water, 3 pt.; bitter almonds, bruised, 1 lb.; essence of lemons, 2 drm.

Oil of Cedrat. See *Crême de Cedrat.*

Orange Cordial.—Like lemon cordial or crême d'orange, from fresh orange peel, ½ lb. to the gal.

Orange Peel, Essence of.—Golden.—Fresh yellow rind of orange, 4 oz.; rectified spirit, ½ pt.; water, ½ pt.; digest for a week, press, filter and add of sherry 1 qt. A pleasant liqueur.

Parfait Amour.—Perfect Love.—1. Flavored with the yellow rind of 4 lemons and a teaspoonful of essence of vanilla to the gal., with sugar, 3 lb., and powdered cochineal, q. s. to color.

2. Sugar, 8½ lb.; 90% alcohol, 5½ lb., dissolved in 6 lb. water; essence of cloves, 1¼ oz.; essence of mace, 3 drm.; essence of lemon, 1 drm.; colored rose.

Peach Cordial.—Pour 3½ gal. alcohol, 90%, Tr. over 2 lb. sliced peaches. Digest from 8 to 10 days. Filter and add 3 gal. white wine, 15½ lb. sugar dissolved in 3½ qt. water.

Peppermint.—Peppermint Cordial; Sportsman's Cordial; Eau de Chasseurs.—This well-known compound is perhaps in greater demand in every part of the kingdom than all the other cordials put together.—1. From peppermint water and gin or plain spirit, 22 u. p., of each 1 pt.; lump sugar, ¾ lb.

2. Wholesale.—English oil of peppermint, 5 oz., is added to rectified spirits of wine, 3 pt.; and the mixture is agitated well together for some time in a corked bottle capable of holding 4 pt. or more; it is then emptied into a cask having a capacity of upward of 100 gal., and 36 gal. of perfectly white and flavorless proof spirit is poured in, and the whole well agitated for ten minutes; a solution of the best double refined lump sugar, 2¾ cwt., in about 35 gal. pure filtered rain water, is then added, and the contents of the cask well rummaged up in the usual manner for at least fifteen minutes; sufficient clear rain water to make up the whole quantity to exactly one hundred gallons, and holding in solution 5 oz. alum, is next added, and the whole is again well agitated for at least a quarter of an hour, after which the cask is bunged down, and allowed to repose for a fortnight before it is broached for sale.

3. Pure proof spirits, 3½ gals.; essential oil of peppermint, 1¼ drm., cut first in 1¼ qt. strong alcohol; pure soft water, 7½ gal.; simple sirup, 2½ gal. Agitate, and if not clear add 2½ drm. alum dissolved in 1¼ pt. rain water. Let it stand 10 days.

Peppermint Water.—Pepperment flowers, 1 k.; water, 4 l.; salt, 250 grammes; macerate, and draw off 2 liters.

Pimento.—*Syn.* Pimento Cordial, Pimento Dram.—Rather strongly flavored with allspice or pimento. It has obtained a great repute in the West Indies in diarrhœa, cholera, and bowel complaints generally.

Pineapple Cordial.—Pineapple extract, 3 oz.; extract of lemon, ¾ oz.; sirup, 1½ gal.; rectified spirits, 2¼ gal.

Pineapple Liqueur.—Take ½ lb. of peeled pineapple, and cut it into slices; boil 3 qt. of sirup until it registers 38° on the saccharometer; add the slices of pineapple, the juice of 4 oranges and the yellow peel of 2 oranges; let it boil up, and pour the whole into a jar. Close the jar carefully, and let the pineapple infuse thus for two days. Strain the sirup through a hair sieve, mix with 1 qt. of 90% alcohol registering 35° by Gay Lussac's alcoholometer, and filter the whole through a felt filtering bag. Bottle the liqueur, and keep in a dry place.

Quince Liqueur.—Grate a sufficient quantity of quinces over a basin to obtain 2 lb. of pulp; add 1 qt. of sirup registering 30° on the saccharometer; cover the basin, and let it remain thus for one day. Pour the contents of the basin into a filtering bag, add 1 pt. of 90% alcohol, registering 35° by Gay Lussac's alcoholometer, to the strained sirup; mix, and pour the whole again through a filtering bag and bottle the liqueur.

Raspberry Cordial.—From raspberry brandy, sirup, and water, equal parts. A similar article is prepared by flavoring sweetened spirit

with the artificial raspberry essence.

Ratafia.—Originally a liqueur drunk at the ratification of an agreement or treaty. It is now the common generic name in France of liqueurs compounded of spirit, sugar, and the odoriferous and flavoring principles of vegetables, more particularly of those containing the juices of recent fruits, or the kernels of apricots, cherries, or peaches. In its restricted sense this name is commonly understood as referring to cherry brandy or peach brandy.

The following list includes those ratafias which are commonly prepared by the French liquerists:

Ratafia d'Angelique.—From angelica seeds, 1 dr.; angelica stalks, 4 oz.; blanched bitter almonds, bruised, 1 oz.; proof spirit or brandy, 6 qt.; digest for 10 days, filter; add, of water, 1 qt.; white sugar, 3½ lb.; mix well, and in a fortnight decant the clear portion through a piece of clean flannel.

Ratafia d'Anis. See *Aniseed Cordial.*

Ratafia de Baume de Tolu.—From balsam of tolu, 1 oz.; rectified spirit, 1 qt.; dissolve, add water, 3 pt.; filter, and further add of white sugar, 1½ lb.

Ratafia de Brou de Noix.—From young walnuts with soft shells pricked or pierced, 60 in number; brandy, 2 qt.; mace, cinnamon, and cloves, of each 15 gr.; digest for 8 weeks; press, filter, add of white sugar, 1 lb., and keep it for some months before decanting it for use.

Ratafia de Cacao.—Ratafia de Chocolat.—From Caracca cacao nuts, 1 lb.; West Indian cacao nuts, ½ lb., both roasted and bruised; proof spirit, 1 gal.; digest for 14 days, filter, and add, of white sugar, 2½ lb.; tincture of vanilla, ½ dr. (or a shred of vanilla may be infused with the nuts in the spirit instead); lastly, decant in a month, and bottle it.

Ratafia de Café.—1. From coffee, ground and roasted, 1 lb.; brandy or proof spirit, 1 gal.; sugar, 2 lb. dissolved in water, 1 qt.; as last.

2. Coffee, 1 lb.; brandy, 6¼ lb.; macerate the coffee in the brandy for seven or eight days, and then distill over a water bath, and to the distillate add a very clear sirup, made by dissolving 2½ lb. of the best sugar in 4 lb. of water. This liqueur has all the aroma and none of the bitterness of the coffee.

Ratafia de Cassis.—From black currant juice, 1 qt.; cinnamon, 1 dr.; cloves and peach kernels, of each, ½ dr.; brandy, 1 gal.; white sugar, 3 lb.; digest for a fortnight, and strain through flannel.

Ratafia de Cerise.—From Morello cherries, with their kernels, bruised, 8 lb.; brandy or proof spirit, 1 gal.; white sugar, 2 lb.; as last.

Ratafia de Chocolat.—Ratafia de cacao (*see ante*).

Ratafia de Coings.—From quince juice, 3 qt.; bitter almonds, 3 dr.; cinnamon and coriander seeds, of each, 2 dr.; mace, ½ dr.; cloves, 1 gr., all bruised; rectified spirit, quite flavorless, ½ gal.; digest for a week, filter, and add of white sugar, 3½ lb.

Ratafia de Coings (Quinces).—Expressed juice of ripe quinces, 0·6 l.; spirit of cloves, 0·05 l.; alcohol, at 0·85°, 2·5 l.; sugar, 1·25 k.; water, 6 l.; color yellow with caramel.

Ratafia de Crême.—From crême de noyeau and sherry, of each ½ pint; sirup, ½ pt.; fresh cream, 1 pt.; beaten together.

Ratafia de Curaçoa. See *Curaçoa.*

Ratafia de Framboises.—Raspberry Cordial.—To 1¼ lb. of raspberry juice add ¼ lb. of cherry juice; boil this with 2 lb. of sugar; add 4 pt. of brandy, and let it macerate for a fortnight; filter.

Ratafia de Framboises (Raspberries).—Infusion of raspberries, 3 l.; infusion of wild cherries, 1 l.; alcohol, 85°, 1 l.; sugar, 5 k.; water, 1·60 l.

Ratafia de Genièvre.—From juniper berries, each pricked with a fork, ¼ lb.; caraway and coriander seed, of each, 40 gr.; finest malt spirit, 22 u. p., 1 gal.; white sugar, 2 lb.; digest a week, and strain with expression.

Ratafia de Grenoble.—From the small wild black cherry with the kernels bruised, 2 lb.; proof spirit, 1 gal.; white sugar, 3 lb.; citron peels, a few grains, as before.

Ratafia de Grenoble, de Teyssère.—From cherries bruised with the stones, 1 qt.; rectified spirit, 2 qt.; mix, digest for forty-eight hours, then express the liquid, and heat it to boiling in a close vessel; when cold, add of sugar or sirup, q. s., together with some noyeau, to flavor, and a little sirup of the bay laurel, and of galangal; in three months decant and bottle it.

Ratafia de Noyeau.—From peach or apricot kernels, bruised, 120 in number; proof spirit or brandy, 2 qt.; white sugar, 1 lb.; digest for a week, press and filter.

Ratafia d'Œillets.—From clove pinks, without the white buds, 4 lb.; cinnamon and cloves, of each, 15 gr.; proof spirit, 1 gal.; macerate for ten days, express the tincture, filter, and add of white sugar, 2½ lb.

Ratafia d'Ecorce d'Orange.—Crême d'Orange.

Ratafia d'Fleurs d'Orange.—From fresh orange petals, 2 lb.; proof spirit, 1 gal.; white sugar, 2½ lb.; as last. Instead of orange flowers, 1 dr. oil of neroli may be used.

Ratafia à la Provencale.—From striped pinks, 1 lb.; brandy or proof spirit, 1 qt.; white sugar, ¾ lb.; juice of strawberries, ¾ pt.; saffron, 20 gr.; as before.

Ratafia des Quatre Fruits.—From cherries, 30 lb.; gooseberries, 15 lb.; raspberries, 8 lb.; black currants, 7 lb.; express the juice, and to each pint add, of white sugar, 6 oz.; cinnamon, 6 gr.; cloves and mace, of each, 3 gr.

Ratafia Rouge.—From the juice of black cherries, 3 qt.; juices of strawberries and raspberries, each, 1 qt.; cinnamon, 1 dr.; mace and cloves, of each, 15 gr.; proof spirit or brandy, 2 gal.; white sugar, 7 lb.; macerate, etc., as before.

Ratafia Sec.—Take of the juice of gooseberries, 5 pt.; juices of cherries, strawberries and raspberries, of each, 1 pt.; proof spirit, 6 qt.; sugar, 7 lb.; as before.

Ratafia à la Violette.—From orris powder, 3 oz.; litmus, 4 oz.; rectified spirit, 2 gal.; digest for ten days, strain, and add of white sugar, 12 lb., dissolved in soft water, 1 gal.

Rhubarb Cordial.—Rinse gently 40 lb. best quality of rhubarb stalks in a 15 or 20 gal. tub. Add 4 gal. water, stir and squeeze the pulp with the hands so as to separate the juice. Let it rest for a few hours, strain, and press through a coarse cloth. The residue may have 1 gal. more of water pressed through it. Add 30 lb. loaf sugar, and after its solution, water to make it up to 10½ gal. Put in a tub covered with a blanket and some boards at 55° to 60° F. until it begins to ferment. Then put into a cask, a portion at a time, as its working decreases until all is in. Let the scum as it works run

out of the bung hole. When nearly through fermenting drive the bung, put in a spile, which is to be removed every few days until the barrel is safe from bursting. Use more or less sugar according to the strength and sweetness desired.

Rose Cordial.—Extract of rose, 1 oz.; sirup, 2 qt.; rectified spirit, 3 qt.

Rosoli.—Rose leaves, 8¾ oz.; orange flower water, 4 pt.; Ceylon cinnamon, 124 gr.; cloves, 1 oz.; macerate the rose leaves, the cinnamon, and the cloves in 17½ pt. spirit, and distill; and to the distillate add 15 oz. of sugar dissolved in 4 pt. orange flower water.

Rosolio de Turin.—Essence of anise, 2·50 gr.; essence of fennel, 0·30 gr.; essence of bitter almonds, 3 gr.; essence of roses, 0·60 gr.; essence of ambergris, 0·40 gr. Color with cochineal.

Signs of Love.—1. From proof spirit (flavored with otto of roses) and sirup in equal parts.

2. From sugar, 6 lb.; pure soft water, q. s. to produce 1 gal. sirup, to which add, of eau de rose, 1 pt.; proof spirit, 7 pt. It is colored a pale pink by powdered cochineal. A very pleasant cordial. A drop or two, not more, of essence of ambergris or vanilla improves it.

Strawberry Cordial.—1. Proof spirit, 6¼ gal. strawberries, 10 qt.; digest for ten days, and draw off; add soft water, 3¾ gal.; simple sirup, 2½ gal. Agitate, and color it desired.

2. Juice of fresh strawberries, 1½ pt.; sirup, 3 qt.; rectified spirit, 3 qt. Color with liquid carmine, q. s.

Tears of the Widow of Malabar.—As balm of Molucca, but employing cloves bruised, ½ oz., mace shredded, 1 dr., and a teaspoonful of essence of vanilla for flavoring; ¼ pt. of orange flower water is sometimes added. It is slightly colored with burnt sugar.

Trappistine.—Large absinthe, 40 gr.; angelica, 40 gr.; mint, 80 gr.; cardamom, 40 gr.; balm, 20 gr.; myrrh, 20 gr.; calamus, 20 gr.; cinnamon, 4 gr.; cloves, 4 gr.; mace, 2 gr.; alcohol at 85°, 4·5 l.; white sugar, 3·750 k. Follow the method given for chartreuse. After two days of maceration, distill and rectify. Add sirup and color green or yellow.

Usquebaugh.—*Syn.* Escubac. Literally, mad water, the Irish name of which whisky is a corruption. It is applied to a strong cordial spirit, much drank in Ireland, and made in the greatest perfection at Drogheda.

1. Brandy or proof spirit, 3 gal.; dates without their kernels and raisins, of each, bruised, ¼ lb.; juniper berries, bruised, 1 oz.; mace and cloves, of each, ¾ oz.; coriander and aniseed, of each, ½ oz.; cinnamon, ¼ oz.; macerate, with frequent agitation, for fourteen days, then filter and add of simple sirup, 1 gal.

2. Pimento and caraways, of each 3 oz.; mace, cloves and nutmegs, of each 2 oz.; aniseed, corianders and angelica root, of each 8 oz.; raisins, stoned and bruised, 14 lb.; proof spirit, 9 gal.; digest as before, then press, filter or clarify and add of simple sirup, q. s. Should it turn milky, add a little strong spirit or clarify it with alum or filter through magnesia.

Usquebaugh is either colored yellow with saffron (about ¼ oz. per gal.), or green with sap green (about ½ oz. per gal.); either being added to the other ingredients before maceration in the spirit.

Vanilla Liqueur.—Two sticks of vanilla, 3 pt. of brandy or proof gin, 1 lb. of sugar. Break up the vanilla into the spirit, cork and let it infuse a fortnight. Boil the sugar in a quart of water to a clear sirup, then pour in the spirit and vanilla and simmer 10 minutes. Filter and bottle.

Vanilla Cordial.—Put 1¼ oz. of vanilla beans in 3 qts. alcohol and 1½ gallons of water. Macerate for a few days, then distill. Add to this 11 lbs. of sugar. After it is dissolved, color with cochineal and filter.

Huile de Vanille.—Infusion of vanilla, 0·80 l.; alcohol, at 85°, 2.40 l.; white sugar, 4·35 k.; water, 3·9 l.

Vermouth.—As the celebrated Vermouth de Turin cannot be made in this country to advantage, the receipt of Ollivero is given. Coriander, 500 gr.; rinds of bitter oranges, 250 gr.; orris root, powdered, 250 gr.; elder flowers, 200 gr.; red cinchona, 150 gr.; calamus, 150 gr.; large absinthe, 125 gr.; holy thistle (*Centaurea benedicta*), 125 gr.; elecampane (roots), 125 gr.; little centuary, 125 gr.; germander, 125 gr.; Chinese cinnamon, 100 gr.; angelica (roots), 65 gr.; nutmegs, 50 gr.; galanga, 50 gr.; cloves, 50 gr.; cassiae, 30 gr.; white wine of Picardy, 100 l. Digest for five or six days, draw off the liquor, size with fish glue, and allow to stand for fifteen days.

Vermouth au Madère.—Large absinthe, 125 gr.; angelica roots, 60 gr.; holy thistle, 125 gr.; burgwort, 125 gr.; veronica, 125 gr.; rosemary, 125 gr.; rhubarb, 30 gr.; red cinchona, 200 gr.; orris root, powdered, 250 gr.; infusion of curaçoa, 25 centiliters; common Madeira wine, 92 l.; raisin sirup, 3 l.; cognac at 40°, 5 l. Digest for three days, draw off the clear, size with fish sounds; after eight days of rest, rock and size again before bottling.

Vespetro by Essences.—Essence of anise, 3 gr.; essence of caraway, 2 gr.; essence of fennel, 0·60 gr.; essence of coriander, 0·80 gr.; essence of lemon, distilled, 1 gr.; alcohol at 85°, 2·80 l.; water, 6·60 l.; sugar, 2·50 k.

Whisky, Bourbon, Imitation of.—1. Nine gal. of proof spirit, 1 gal. Bourbon highly flavored, 1 qt. malt whisky, 1 gill white vinegar, 1 gill sirup and 10 to 20 minims of cognac oil dissolved in alcohol. Color with the aid of caramel.

2. Forty gal. rectified whisky; 1¼ oz. Bourbon oil dissolved in 1 pt. alcohol, 88%; 1 pt. white sugar sirup.

3. *Irish.*—Forty gal. rectified whisky; 4 to 6 oz. Irish whisky oil, dissolved in 1 pt. alcohol, 88%; 1 lb. double refined glycerine.

4. *Monongahela.*—Forty gal. rectified whisky; 1¼ oz. Monongahela oil, dissolved in 1 pt. alcohol, 88%; 1 pt. white sugar.

5. *Rye.*—Forty gal. rectified whisky; 1¼ oz. rye oil, dissolved in 1 pt. alcohol 88%; 1 pt. white sugar sirup.

6. *Scotch.*—Forty gal. rectified whisky; 4 to 6 oz. Scotch whisky oil, dissolved in 1 pt. alcohol 88%; 1 lb. double refined glycerine.

7. *Wheat.*—Forty gal. rectified whisky; 1¼ oz. wheat whisky oil, dissolved in 1 pt. alcohol, 188%; ½ oz. malt oil; 1 lb. double refined glycerine.

PUNCH

Punch.—Punch is a beverage made of various spirituous liquors or wine, hot water, the acid juice of fruits, and sugar. It is considered to be very intoxicating; but this is probably because the spirit being partly sheathed by the mucilaginous juice and the sugar, its strength does not appear to the taste so great as it really is. Punch, which was almost universally drunk among the middle classes about fifty or sixty years ago, has almost disappeared from our domestic tables, being superseded by wine. There are many different varieties of punch. It is sometimes kept cold in bottles, and makes a most agreeable summer drink.

1. Juice of 3 or 4 lemons; yellow peel of 1 or 2 lemons; lump sugar, ¾ lb.; boiling water, 3½ pt.; infuse ½ hour, strain, add porter ½ pt.; rum and brandy, of each ¾ to 1 pt. (or either alone 1½ to 2 pt.) and add more warm water and sugar, if desired weaker or sweeter.

2. To Make Hot Punch.—Ingredients.—½ pt. rum, ½ pt. brandy, ¼ lb. sugar, 1 large lemon, ½ teaspoonful of nutmeg, 1 pt. of boiling water. Rub the sugar over the lemon until it has absorbed all the yellow part of the skin; then put the sugar into a punchbowl; add the lemon juice (free from pips), and mix these two ingredients well together. Pour over them the boiling water, stir well together, add the rum, brandy and nutmeg; mix thoroughly and the punch will be ready to serve. It is very important in making good punch that all the ingredients are thoroughly incorporated; and to insure success, the processes of mixing must be diligently attended to. Allow a quart for 4 persons; but this information must be taken *cum grano salis;* for the capacities of persons for this kind of beverage are generally supposed to vary considerably.

3. Cold Punch.—Arrack, port wine, water, of each 1 pt.; juice of 4 lemons; sugar, 1 lb.; mix.

Arrack Punch, Imitation.—Two or three preserved tamarinds dissolved in a bowl of any kind of punch will impart to it a flavor closely resembling arrack.

Brandy.—1. To 1 pt. Cognac brandy, ½ pt. of Jamaica rum, ½ pt. of peach brandy, add 2 lb. white sugar, 1 gill of lemon and 1 gill of lime juice; mix all well together, and add ice equal to 2 qt. of water; cut 2 lemons into thin slices, peel and slice thin 1 pineapple; add these to the punch and let stand to ripen and blend for 1 hour before using.

2. To 1 teaspoonful of raspberry sirup add 1 tablespoonful white sugar, 1 wineglass brandy, the same quantity of water, a small piece lemon, 2 slices of orange, 1 piece of pineapple. Fill the tumbler with shaved ice, shake well, and dress the top with berries in season; sip through a straw.

3. Take 3 doz. lemons, chip off the yellow rinds, taking care that none of the white underlying pith is taken, as that would make the punch bitter, whereas the yellow portion of the rinds is that in which the flavor resides and in which the cells are placed containing the essential oil. Put this yellow rind into a punch bowl, add to it 2 lb. of lump sugar, stir the sugar and peel together with a wooden spoon or spatula for nearly ½ hour, thereby extracting a greater quantity of the essential oil. Now add boiling water, and stir until the sugar is completely dissolved. Squeeze and strain the juice from the lemons and add it to the mixture; stir together and taste it; add more acid or more sugar, as required, and take care not to render it too watery. "Rich of the fruit and plenty of sweetness," is the maxim. Now measure the sherbet, and to every 3 qt. add 1 pt. of Cognac brandy and 1 pt. of old Jamaica rum, the spirit being well stirred as poured in. This punch may be bottled and kept in a cool cellar; it will be found to improve with age.

Claret.—1. To a large punch bowl half filled with broken ice add 2 lb. of pulverized sugar; 6 oranges cut crosswise into thin slices, 6 bottles of claret, and 1 bottle of champagne; mix well together and let stand for one hour before using.

2. Take 1 tablespoonful of sugar, a small slice of lemon, 2 or 3 slices of orange. Fill the tumbler with shaved ice, and then pour in the claret, shake well, and ornament with berries in season. Place a straw in the glass.

3. Take 1½ tablespoons sugar, 1 slice of lemon, 2 or 3 slices orange. Fill the tumbler with shaved ice; pour in the claret; shake well.

Gin Punch.—1. To half a pint of old Holland gin add 1 gill of maraschino, the juice of 2 lemons, and the yellow rind of 1 previously infused in the gin, 2 gills of simple sirup or 4 oz. of pulverized sugar, and 1 qt. of seltzer water. Mix well and freeze to a semi-solid.

2. Yellow peel and juice of 1 lemon; gin, ¾ pt.; water, 1¾ pt.; sherry, 1 glass.

Iced.—Champagne or Rhenish wine, 1 qt.; arrack, 1 pt.; juice and yellow peels of 6 lemons; white sugar, 1 lb.; soda water, 1 or 2 bottles; ice as cream.

Milk Punch.—1. Take 1 tablespoonful sugar; 2 tablespoonfuls water; 1 wineglass brandy; ½ wineglass Santa Cruz rum; ½ tumbler shaved ice. Fill with milk and shake well; grate a little nutmeg on top.

2. Yellow rinds of 2 dozen lemons; steep for two days in rum or brandy, 2 qt.; then add spirit, 3 qt. more; hot water, 3 qt.; lemon juice, 1 qt.; loaf sugar, 4 lb.; 2 nutmegs, grated; boiling milk, 2 qt.; mix, and in two hours strain through a jelly bag.

Norfolk.—French brandy, 20 qt.; yellow peels of 30 oranges and 30 lemons; infuse for twelve hours; add 30 qt. of cold water, 15 lb. lump sugar, and the juice of the oranges and lemons; mix well, strain through a hair sieve, add new milk, 2 qt., and in six weeks bottle. Keeps well.

Orange.—As No. 1, using oranges, and adding a little orange wine. A little curaçoa, noyeau, or maraschino improves it.

Princes'.—Put into a freezing can a bottle of sparkling champagne, a gill of maraschino, ½

pt. of strawberry sirup, the juice of 6 oranges, the yellow rind of 1 rubbed on sugar.

Raspberry.—As Norfolk, but using raspberry juice or vinegar for oranges or lemons.

Regent's.—1. Pare off the thin yellow rinds from 4 oranges and 4 lemons; express the juice from the same fruit and strain it; add to it the yellow rinds, with 2 sticks of cinnamon broken up, ½ doz. cloves, and a dessertspoonful of vanilla sugar. Simmer these ingredients very slowly for half an hour in 1 qt. of simple sirup. Express the juice from 1½ doz. of lemons, and add it to the decoction. Then make a strong infusion of the finest green tea and add it to the mixture; after which add equal portions of old Jamaica rum and Cognac brandy, according to the strength required. Mix all well together, strain through a hair sieve, put it into a freezer and make very cold.

2. Strong hot green tea, lemon juice, and capillaire, of each 1½ pt.; rum, brandy, arrack, and curaçoa, of each 1 pt.; champagne, 1 bottle; mix, and slice a pineapple into it.

Tea.—Hot tea, 1 qt.; arrack, ½ bottle; white sugar, 6 oz.; juice of 8 lemons; yellow rinds of 4 lemons.

Wine.—Sugar, 1 lb.; yellow peel of 3 lemons; juice of 9 lemons; arrack, 1 pt.; port or sherry wine (hot), 1 gal.; cinnamon, ¼ oz.; nutmeg, 1 drm.

Whisky.—To 1 wineglass of whisky add 2 wineglasses of hot water, and then sugar to taste. Dissolve the sugar well with 1 wineglass of the water, then pour in the whisky, and add the balance of the water; sweeten to taste, and put in a small piece of lemon rind or a thin slice of lemon.

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of this application upon polished brass or copper is extremely beautiful, the surface resembling silver, and keeping its lustre for a long time. The author of the process has applied it to great advantage in his laboratory, for the purpose of coating articles of iron, steel, and copper, thereby protecting them against rust. One difficulty in the process results from the fact that only a very thin layer of tin can be applied. Should it become practicable to impart a thicker coating, it will probably acquire great importance. Experiments upon nickelizing metallic substances in a similar manner are in course of progress by the author, although thus far without satisfactory result.

CLEANSING FLUID.

A convenient preparation for taking out oil spots, and for cleansing articles of brass, silver-plated ware, and gold, is made by mixing together equal parts of caustic ammonia and spirits of soap; and this may be applied to a great variety of purposes in household economy.

OZONE PRODUCED BY FLOWERS AND ESSENCES.

According to Professor Montegazza, certain vegetable essences exercise an important influence in the production of atmospheric ozone, this being most marked in the case of mint, cloves, lavender, lemon, thyme, nutmeg, etc., which in contact with atmospheric oxygen in light cause the development of a large quantity of ozone, equal, if not superior, in amount to that produced by electricity or by the decomposition of the permanganate of potash. According to the author the oxidation of these essences is one of the most convenient means of producing ozone, since, even when in very minute quantity, a great effect is accomplished. In most cases these essences require for the purpose the direct rays of the sun; occasionally the effect is extremely slight. In certain instances the action, commenced in solar light, was found to continue in darkness. In some experiments a vessel perfumed with essence, and then washed with alcohol and perfectly dried, still developed a proportionate quantity of ozone, provided it contained a slight odor of the essence. In addition to the substances mentioned, spirits of turpentine, Cologne-water, and other perfumes and aromatic tinctures, are also capable of accomplishing the same result. Certain flowers, as the narcissus and hyacinth, also develop ozone in closed vessels. As an inference drawn by the professor from these experiments, he recommends the cultivation of flowers in marshy districts and in places infected with animal emanations, since the ozone thus produced will tend to destroy them. For the same reason flowers of agreeable odor should be cultivated about residences and in gardens, as this may be considered a direct sanitary precaution of much importance.

DEVELOPMENT OF OZONE BY THE BATTERY.

Professor Boettger informs us that if a solution of nitrate of bismuth be decomposed by the galvanic current, an uncommonly large amount of ozone is developed at the pole connected with the platinum element, while the platinum itself becomes coated with a layer of superoxide of bismuth at the same time. By a similar treatment of a silver or lead salt there is a like deposit of superoxide of these metals, but without any special development of ozone.

GLUCOSE IN FERMENTING LIQUIDS.

A paper was recently presented before the Chemical Society of London upon fermentation, in which it was stated, as an important deduction from experiments, that the addition of glucose to fermenting liquids, especially to the juice of the grape, helps to exhaust the fermentative element, and thus imparts to the fermented liquid a greater keeping power, and also, that each ferment has its favorite soil. In the course of some remarks upon the paper it was stated that the yeast organism, though generally called a plant, is rather an animal in its functions, since the products it secretes are less complicated than those it takes in, and it absorbs no heat like plants, nor does it require light for its vital processes.

DANGER FROM USING THE WASTE GAS OF FURNACES.

Attention has just been called by Dr. Percy, an eminent metallurgist, to the danger of using waste gas from the blast furnace. A principal ingredient of this gas, as is well known, consists of carbonic oxide, the inhalation of which, in very small quantities, whether pure or mixed with air, is sufficient to destroy life. The employment of the waste gas of blast furnaces for heating steam-boilers, etc., is extending daily, and Dr. Percy fears that deaths from its inhalation may become frequent, unless those who use it are fully aware of its physiological action. Numerous cases of poisoning of this kind are already on record.

HULLING GRAIN.

Various methods for removing the husk from grain, by means of some harmless chemical application, have recently been suggested, so that the grain may be afterward pounded up in a mortar and converted into bread without the necessity of sending it to a mill to be ground. Besides the recommendation of simplicity, it is claimed that a great gain is accomplished in the saving of a large percentage of the gluten and other nutritious elements, which, under ordinary circumstances, would be entirely lost. Among processes for this purpose, one recently patented by a German inventor consists in dissolving two parts of calcined soda in twelve parts of water, with the addition of one part of caustic lime and three of water. This is to be boiled from one and a half to two hours, and then twenty times its weight of water added. Seven and a half quarts of the liquid thus prepared will suffice for 220 pounds of grain. The liquid is to be poured over the grain by means of a watering-pot, or otherwise, and the whole stirred about for fifteen or twenty minutes, during which time the hull of the grain becomes detached, and may be removed by the ordinary methods.

It is asserted that this lye does not penetrate into the substance of the grain so as to affect its composition, but acts solely upon the husk. No fermentation is produced by it, even when the grain has been moistened for a long time. There is, of course, no objection to grinding the grain thus prepared in the ordinary way. The flour may not be very white, but it is claimed to possess nutritive qualities of the highest value.

PYROPHOTOGRAPHY.

Among the numerous applications of photography to the arts may be mentioned one called pyrophotography; or, in other words, the production of translucent photographic pictures on glass by means of a fusible silicious color. A mixture of honey, glycerine, and a gummy substance, dissolved in water, is poured upon a glass plate, forming a thin, sticky stratum. This, dried at a moderate heat, becomes hard, but possesses the property of slowly absorbing water from the atmosphere and again becoming sticky. If a quantity of bichromate of potash be added to the mixture before laying it on, its properties are modified so that, when exposed under a negative, the illuminated portions lose their stickiness and become permanently horny in texture; while the shaded portions will, in a few minutes, become sticky again, in proportion to the depth of the

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WINES AND WINE MAKING

Wine Making.—The grapes are not removed from the vine until they are quite ripe. As the maturation not only of different varieties, but of the same kind, is dependent upon the season, no stated period can be fixed for the commencement of the vintage. The grapes are ready to be gathered when the white kind becomes of a brownish yellow color, and the red or blue, very dark purple or nearly black. Shears, pruning knives, or scissors, are used for the removal of the fruit from the vine.

In making the finer wines, previous to being pressed, the bunches are carefully examined, and any unripe or damaged grapes are picked off and used to make inferior wine, or in the gathering the unripe specimens are left on the branch to ripen. The blue and dark varieties, when intended for the best wines, are, with few exceptions, removed from the stalks before being pressed; the white grapes are pressed with the stalks.

Except with those grapes which produce wines that are likely to become viscous or ropy, the stalks are not left for any length of time in contact with the grape juice or must. There are various modes of separating the grapes from the stalks. One method consists in the employment of a wooden fork or trident, ½ yd. or more in length; by turning this round in a wooden pail filled with the fruit, the grapes become detached from the stalks, which are thus brought to the surface and removed.

In another contrivance the separation is effected by inclosing the bunches in cages made of parallel wires. Inside the cage there is a stirrer; when this is turned by an external handle, the grapes alone drop through the wires, leaving the stalks in the cage. Sometimes the separation is accomplished by means of hurdles, which are so manipulated that the fruit only shall pass through the meshes.

Previous to their being pressed, the grapes have to undergo the preliminary process of bruising or crushing. This is sometimes done by their being trodden under the naked feet of men, on a large wooden stage or platform; at other times the men wear heavy boots, while in some cases the grapes are placed in a vat and bruised with a kind of wooden pestle. Sometimes they are crushed between wooden grooved rollers. Of all these processes, the first, although the least cleanly, possesses the advantage of not crushing the pips or stalks, and is thus free from the risk of imparting an unpleasant flavor to the wine.

There is considerable divergence in the statements of different writers as to the yield of must or juice from ripe grapes. Payen says it amounts to from 94 to 99% of the total weight of the grape. Dupré and Thudichum obtained from three samples of grapes respectively 78·75%, 76·75%, and 72·25%. Wagner averages it from about 60 or 70%.

When a white wine is required, the bruised grape, whether of the white or red variety, is at once pressed, except when, as happens with some kinds of fruit, it is kept to allow of the development of the bouquet. The mode of procedure is different when a red wine is to be prepared. The crushed grapes must then be kept in a tub or vat, loosely covered over, until an examination of a small quantity of the juice shows it has acquired the necessary color. For it to do this sometimes takes from three or four days to a month.

During this period, alcohol has been formed in the pulp, and this, with the tartaric acid of the fruit, has dissolved out the coloring principle of the grape. Great care is necessary at this stage to prevent the too long exposure of the crushed and fermenting fruit to the air.

Wine presses are of various patterns.

In many wine making establishments, iron presses have supplanted wooden ones, over which they possess the advantages of greater cleanliness and non absorption of the must. The wine press in general use in the Gironde consists of a tall, round basket, made of perpendicular laths. The fruit is placed in this basket, and upon the fruit a wooden block, to which a screw is attached; a nut works upon the screw from above downward, and presses the wooden block upon the fruit, the liquid from which is forced out through the laths and collected.

In the manufacture of champagne and some red wines, very powerful presses are employed; but these possess the objection of pressing the fixed oil from the pips and an unpleasantly tasting juice from the stalks, and thereby damaging the product. In some establishments, centrifugal machines have been used, not only with the result of yielding a better wine, but of effecting a considerable gain in time and labor.

The must, being received into proper receptacles, next undergoes the vinous fermentation. In the case of white wines the must is kept separate from that subsequently procured by submitting the husks, pips, and stalks to additional pressure, and is sold as the first or superior wine.

But with red wines the husks (and in some cases the marc) are thrown into the fermenting vat, by which means the wine acquires an additional amount of coloring matter. In this case, when the completed wine is drawn off, the husks are again pressed, and the wine so obtained added to the first instalment. As the tannic acid is derived from the skins and seeds of the grape, wines prepared in this manner usually contain a considerable amount of this substance.

The fermentation is conducted in different countries at different temperatures, and, of course, with different results. When must is fermented at 15° to 20° Cent. (59° to 68° Fah.) it yields a wine strong in alcohol, but wanting in bouquet; while if the fermentation be carried on at 5° to 15° Cent. (41° to 59° Fah.) the product will be a wine rich in bouquet, but poor in alcohol.

The wines of Spain, the south of France, Aus-

tria and Hungary, are produced at the higher temperature, and those of Germany, for the most part at the lower one. The fermentation is carried on in large wooden vats. In some places vats of sandstone or brick are used for this purpose. The fermentation of white wines, such as those of the Rhine and Gironde, is effected in new and perfectly clean casks or hogsheads, the bungholes of which are left open to allow the escape of the carbonic acid. Opinions differ as to whether air should be admitted or not during fermentation. The process is undoubtedly quickened if the must be aerated. The aeration is sometimes performed by a bellows fitted with a rose nozzle. During the operation of blowing in, the must is to be kept at a low temperature, to prevent the volatilization of the bouquet. When the opposite method is followed, various devices are in use for excluding the air, or at any rate an excess of it. In some cases the vat, being provided with a suitable lid, has a hole, or is arranged with a tube, for the escape of the carbonic acid. Koles and Bamberger accomplish the same end, without letting in the external air, by means of a glass tube bent twice at right angles; one limb of the tube passes through the bunghole into the wine and the other or outer limb into a vessel of water. In another contrivance the lid of the vat is fitted with a valve, which, opening only outward, allows of the exit of the carbonic acid.

Red wines are fermented in large and, in most cases, open vats, fitted in the inside with perforated shelves, which, being below the surface of the liquid, prevent the husks rising to the top, and setting up acetous fermentation. After the completion of the fermentation of Burgundy wines, in some places it is the filthy custom for men to enter the vat, and by their vigorous movements to mix the contents.

It is satisfactory to learn that this particularly objectionable practice is getting somewhat into disuse.

The length of time necessary for the completion of the fermentation varies with the locality, the temperature of the apartment, and with the quality of the wine required. In France, for the ordinary descriptions of wine, it generally takes from three days to a week, and in Germany from one to two weeks; with the finer kinds of wine it occupies four, five or six weeks. The progress of the fermentation may be estimated from the specific gravity of the liquid, since as the fermentation proceeds, and the sugar is undergoing conversion into alcohol, the wine, of course, becomes more attenuated and its specific gravity diminishes. It has been calculated that half per cent. of the alcohol present in the wine escapes during fermentation, as well as a considerable quantity of carbonic acid. An apparatus has been invented for collecting these products, by causing them to pass into water by means of a hydraulic bung.

When the fermentation is over the wine is run into casks, any sediment, such as lees or yeast, being left behind in the fermenting vessel. It is most important that the casks used for this purpose should be absolutely clean. Before a cask is used a second time it should be thoroughly sulphured.

Those wines which contain a large amount of alcohol are sometimes allowed to remain in the fermenting vat until they have cleared; but weak wines are immediately drawn off into the cask, to prevent the setting in of the acetous fermentation. The casks must be filled to the bungholes. A second or minor fermentation takes place in the wine when in the cask, during which tartar or bitartrate of potash is deposited on the sides of the cask, and yeast at the bottom. This second fermentation should be allowed to go on at a low temperature, 5° to 10° C. (41° to 50° F.), and at a slow rate. In some cases it is made to extend to three or six months.

When the second fermentation is over, the casks are filled to the bunghole and securely closed, or the wine is at once drawn into fresh casks to be stored. In these it remains closely bunged up until more tartar is deposited, after which it may be racked off into bottles or casks. When wine is to be stored for any length of time it is necessary to repeat the racking off frequently. Racking is performed by means of a siphon inserted in the bunghole, or by a cock suitably fixed in the cask. If the racked wine is not perfectly clear, it is fined by the addition of isinglass, previously softened by soaking in a small quantity of wine. After the addition of the isinglass, the cask is then filled to the bunghole, closed, and remains undisturbed for about six weeks, and if, at the end of that time, it is not perfectly bright, it is made to undergo a second racking. In wine making countries, blood and solution of glue are sometimes used for fining red wines which contain much tannin. Milk is also occasionally employed for the same purpose. The racking should be performed in cool weather, and preferably in the early spring.

The manufacture of champagne differs in its details from that of the so-called still wine. The best wine is made from a black grape of very fine quality, known as the *Nourien*, or *Pineau*, and grown in the champagne district. None but the best selected grapes are used; all those that are rotten, unripe, or in any way unsound, being rejected. The grapes are gathered when they have attained their greatest size. The vintage commences early in October. To prevent the juice being colored by the skin of the grape, the fruit is submitted to pressure as quickly as possible after being gathered. Very powerful machines are employed for this purpose, since the champagne grape, unlike other varieties, is not previously crushed. Great care is taken to apply the pressure evenly and to conduct the operation with all expedition, for if this exceeds two hours the must will be colored. The grapes are sometimes pressed four times. In good seasons the must obtained from the different pressings is mixed together. In middling ones the first yield is kept for making the best wines, nor is the fourth mixed with the other two. The light colored must is first conveyed into a large vat, where it remains for six, twelve, or eighteen hours, according to the temperature.

At the end of this time certain vegetable matters that would damage the taste of the ensuing wine, as well as render it liable to a second fermentation, become deposited. Directly the must has cleared it is run into small barrels of 2,000 liters capacity, in which it undergoes fermentation. Sometimes the clearing of the juice is accomplished by filtration; at others, when the weather is warm and fermentation sets in so rapidly as not to allow the im-

purities to subside, it is run into casks filled with the fumes from burning sulphur; by this means the excessive fermentative action is arrested, and sufficient time is given for the dregs to settle. The juice having been made clear by either of the above methods, is drawn into barrels, which are arranged in rows in the cellars. The barrels are filled to the bung, the froth which is formed during the fermentation flowing out at the bungholes. In some wine making establishments, the barrels are tightly bunged up, there being previously added to the contents 1% of brandy. The casks are opened at the end of December, and the wine fined by means of isinglass; this operation being conducted at the lowest possible temperature. If, at the end of a fortnight, it has not become bright, it is left for another fortnight, and then, if not clear, it undergoes a second fining. The fining process must be used with caution; when overdone it diminishes, and frequently stops the activity of the subsequent fermentation. To obviate this, the wine should be judiciously exposed to the air, and a minute quantity of yeast added to each hogshead before it is bottled.

When the wine has cleared, before being bottled, cane sugar is added to it, since the quantity of undecomposed natural sugar in the wine is not sufficient to furnish the requisite amount of carbonic acid gas, the ingredient to which champagne owes its effervescent properties.

Champagne bottles constitute a very considerable item in the trade expenses of the wine maker. He pays the glass manufacturer 28 francs a hundred for them; and some wine makers give orders for as many as from 50,000 to 250,000 at a time.

The bottles as they arrive are examined by an experienced person, and those which contain flaws of any kind, or are not perfectly new, symmetrical, and strong are rejected. These average about 10%. The bottles are required to be as nearly as possible of uniform weight and thickness. The inside of each bottle is scrubbed by means of a revolving hair brush and clean water. After being drained, the bottles are rinsed with 90% alcohol and closed with an old but clean cork. They are thus ready, when required, for filling. The wine maker also expends a large amount of money in the purchase of corks, which must be of the best and soundest description. It has been found to be very false economy to use inferior kinds. The wine being drawn into bottles to a height of 2 or 3 inches from the top of the neck, the bottles have next to be corked, the cork being secured in the bottle by a small iron band, called an *agrafe*. All these operations have to be performed deftly and rapidly by experienced workmen. With what speed they are accomplished may be imagined from the fact that an *atelier* of five workmen, who divide the labor, will bottle and cork from twelve to fifteen hundred bottles daily, two bottles passing through all hands in one minute. The corking, etc., finished, the bottles are next placed on their sides, and stacked in cellars or caves, each stack being supported by thin laths.

As the summer approaches, the wine begins to show signs of fermentation, which increases with the hot weather. When the fermentation reaches such a stage as to cause the wine to occupy the previously unfilled space in the neck of the bottle, a large number of bottles begin to burst, as well as to leak; and in some years as much as 30% of the wine is lost from these causes. Two courses, each of which requires to be promptly adopted, are open to the wine maker under these circumstances. Either he must remove the wine to a cooler cellar, or uncork the bottles. Sometimes, if the breakage, or *casse*, as it is termed, has not exceeded 7% or 8% by the time August is reached, he takes the chance of further loss, and lets the wine remain, for with the fall in temperature, which usually occurs in September and October, the energetic action of the wine ceases, and the breakage also.

The leaky and broken bottles are then removed from the sound ones, which are restacked and left until a yeasty substance has discontinued depositing upon their lower sides. The bottles are kept in this condition until required for sale. Before, however, they are in a fit state for the purchaser, the yeasty matter has to be removed, and the wine to be liqueured. The yeast is got rid of as follows: The bottles are placed necks downward, on perforated shelves arranged in rows. A workman then seizes a bottle, and holding it in the inverted position, by a dexterous movement discharges the yeast from the side and brings it down upon the cork. This operation, which extends over some weeks, has to be repeated from time to time, until the supernatant wine is quite clear. The bottles are then very cautiously removed from the cellars to the corking and tying down rooms, when they come into the hands of a workman called a disgorger. The disgorger, holding the bottle still neck downward, proceeds to liberate the cork, by slipping off the *agrafe*, and when the cork is three parts out he quickly inverts the bottle. The cork is then forcibly ejected with a loud report by the froth, which carries with it the greater part of the yeast and other solid matters, what remains of these being got rid of by the workman working his finger round the neck of the bottle, whereby they are detached, and forced out by the still rising froth. The workman then places his thumb over the mouth of the bottle, which is afterward temporarily closed with an old cork.

The liqueur, which is next to be added, is of very varied composition, as almost every champagne maker has his favorite and special preparation.

The best liqueurs are made of some choice wine, mixed with the purest cane sugar. The inferior kinds consist of a mixture of 90% alcohol, sugar and some flavoring material. A certain measured quantity of the liqueur is added to each bottle of wine. The bottle is then corked, wired, tied down and washed, and the cork covered with tin foil and labeled. It is then ready for sale and export. It sometimes happens that after the previous round of operations has been gone through, the champagne becomes turbid, and a minor second fermentation sets in. In this case, it is made to undergo a repetition of the processes already described. It is a desideratum with every champagne maker that when the bottle is opened for its contents to be drunk, the removal of the cork should be accompanied with a full, deep, and distinct report. When, instead of this, the report is short and sharp, and resembles a pop-

ping noise, this is owing to the space between the liquid and the cork, filled with the gas, being too small. When the gas escapes with a hissing noise, it is because the cork fits the neck of the bottle unequally, or has not been driven in in a perfectly straight direction. The good name of any maker would be seriously damaged were he to send out champagne liable to comport itself in this manner. He therefore spares no expense in providing himself with the very best and soundest corks. The best way to prevent the escape of the gas from the bottle is always to keep the bottles lying on their sides.

All effervescing wines are manufactured in a similar manner to champagne.

Since the alcohol in the wine is derived from the sugar contained in the must, it would seem that the sweetest and ripest grapes should yield the strongest product. When the decomposition of the sugar has been complete, this will be the result; but it frequently happens that, owing to an insufficiency in the must of the protein compounds which nourish the yeast cells (the *torula cerevisiæ*), by the agency of which the fermentation is accomplished, the whole of the sugar is not converted into alcohol, in which case a sweet wine will be produced; or the sweetness may be due to the alcohol formed stopping the fermentation before all the sugar had been decomposed, or to an excess of glycerin. If on the other hand, the grape juice is rich in albuminous matter, but poor in sugar, the consequent wine will be what is termed a dry one. Such are the red wines of France and the Rhine.

According to Wagner, red French wines contain 9 to 14% by volume of alcohol. Burgundy, 9, 10, and 11%. Bordeaux, 10, 11, and 12%. Other French wines contain 8 to 10%; the wines of the Palatinate, 7 to 9·5%; Hungarian wines, 9 to 11%. Champagne contains 9 to 12%; Xeres, 17%; Madeira, 17 to 23·7%

In addition to ethylic alcohol and water, which, as shown in the previous table, vary largely in the proportions in which they are present in different kinds of wine, most wines contain the following substances: Propylic, butylic, caprylic and caproic alcohols; acetic and œnanthic ether; grape sugar (dextrose and levulose); glycerin; gums; pectin; coloring and fatty substances; protein bodies; carbonic acid, ordinary and levo-tartaric and racemic acids; citric acid; malic acid; tannic acid; acetic acid; lactic acid; succinic acid; organic and inorganic salts.

Of these, the propylic and butylic, caprylic, and caproic alcohols, the ethers, the glycerin, the carbonic, acetic, lactic, and succinic acids are produced during fermentation, the remaining substances being original constituents of the grape juice, which also contains bitartrate of potash; but this being insoluble in weak spirit, is thrown down or deposited as the conversion of sugar into alcohol proceeds. In its crude condition, it is known as argol, and is the source of cream of tartar and tartaric acid. As a result of its formation in the grape a considerable amount of free acid is removed from the fruit. This is why wine made from grapes is so much superior, and keeps so much

Table Showing the Quantity of Alcohol in Wine.

Names, etc.		Alcohol of 0·7937 per cent. by weight.	Proof spirit per cent. by volume.
Port	Weakest	14·97	31·31
	Mean of 7 samples	16·20	34·91
	Strongest	17·10	37·27
	White	14·97	31·31
Sherry	Weakest	13·98	30·84
	Mean of 13 wines, excluding those very long kept in cask	15·37	33·59
	Strongest	16.17	35·12
	Mean of 9 wines long kept in cask in the East Indies	14·72	31·30
	Madre da Xeres	16·90	37·06
Maderia	Long kept in cask in the East Indies — Strongest	16·90	37·06
	Long kept in cask in the East Indies — Weakest	14·09	30·86
Teneriffe (long in cask at Calcutta)		13·84	30·21
Cercial		15·45	33·65
Lisbon (dry)		16·14	34·71
Shiraz		12·95	28·30
Amontillado		12·63	27·00
Claret (a first growth of 1811)		7·72	16·95
Chateau-Latour (a first growth of 1825)		7·78	17·06
Rosan (second growth of 1825)		7·61	16·74
Ordinary Claret (Vin Ordinaire)		8·99	18·96
Rivesaltes		9·31	22·35
Malmsley		12·86	28·17
Rüdesheimer, first quality		8·40	18·44
Rüdesheimer, inferior		6·90	15·19
Hambacher, superior quality		7.35	16·15

—*Dr. Christison.*

better than that manufactured from fruits that abound instead in citric and malic acids. These latter require the addition of large quantities of sugar to disguise their acidity, a proceeding which frequently gives rise in them to a second fermentation, and often to the consequent formation of acetic acid. The acetic ether in wine is produced by the mutual reaction of acetic acid and ethylic alcohol. Neubauer, dissenting from Dupré and Thudichum, says the œnanthic ether is the constituent to which wines owe their bouquet. He regards this ether as a combination of various substances of which caprylic and caproic acid ethers are the most important. Their formation is believed to take place partly during and partly after fermentation. The rest of the non-volatile constituents, such as the sugar, the gum, the protein bodies, coloring matter, inorganic salts, etc., which remain behind when a wine is evaporated to dryness, constitute, with a certain quantity of substance the composition of which has not been defined, the extractive matter.

The amount of extractive matter in wines varies as greatly as from 1% to 20%. This difference occurs even in wines of a similar character, and from the same district. Thus in Rhine wines it ranges from 1·66% to 4·2%, in the Palatinate wines, from 1·72% to 1·9%, in Bohemian wines, the mean is 2·25%, in the wines of Austria, 2·64%, and in those of Hungary, 2·62%. It is highest in sweet wines. In many adulterated wines, as the extractive matter is either very small or sometimes altogether absent, it has been proposed to employ the estimation of its amount in a wine as a test of its genuineness or the reverse.

Light wines owe their color, varying from pale yellow to brown, possibly to oxidized extractive matter, or to the cask. The color of red wine is due to the action of its free tartaric acid on a blue substance residing in the skin of the grape. This body, which is known to wine makers as wine blue, and which bears a great resemblance to litmus, in turning red when acted upon by acids, was named *œnocyan* or *œnocyanin*, by Mulder or Maumené. It is insoluble in water, alcohol, ether, olive oil, and oil of turpentine, but is dissolved by alcohol containing small quantities of tartaric or acetic acid. Glycerin was found to be a normal constituent of wine by Pasteur in 1850. As the wine matures, the glycerin disappears. In Austrian wines, Pohl found 2·6% of glycerin. In some wines it reaches 3%, but in most it seldom exceeds 1%. In old wines it exists only in very small quantity. Faure states that another normal constituent of wine is a gum, to which is given the name *œnanthin*.

The ash of wine, as might be expected, contains the same fixed constituents as that of the grape juice, and in both the potash and phosphoric acid largely predominate.

As the excellence and character of a wine depend, in addition to its peculiar bouquet, upon the relative proportions of alcohol, free acid, and water, and as these are approximately constant in all wines of good quality, it is essential that the grape juice should not only contain such an amount of sugar as when fermented will yield the requisite quantity of alcohol (but since the goodness of the wine is inversely as its content of free acid), that the latter should not exceed a certain limit. The taste of a wine, however, is frequently a fallacious test as to the quantity of free acid in it. Of two wines, one containing more free acid than the other, the latter may be less sour to the palate, provided it contains a larger proportion of sugar, glycerin, or alcohol than the former.

Apart from the consideration, whether the acid of the grape eventually becomes transformed into sugar or not, the fact remains that in sunless and wet years, when the fruit has not sufficiently ripened, there is a deficiency of sugar, and an access of acid. Fresenius states that the proportions are in—

Grapes grown in a very inferior year as 1 part of acid to 12 parts of sugar. Grapes grown in a better year as 1 part of acid to 16 parts of sugar. Grapes grown in a good year as 1 part of acid to 24 parts of sugar.

According to the same authority, when the proportion reaches 1 part of acid to 10 parts of sugar the grape is unsuited for making wine.

To get over the difficulty of dealing with a must that contains too low a proportion of sugar and too high a one of acid, two methods are adopted by the wine maker. The first, which was proposed by Chaptal, in an essay on the cultivation of the grape, published so long ago as 1800, consists in adding raw sugar to the must, in quantity sufficient to yield the amount of alcohol in which the wine would be otherwise deficient. Chaptal calculated that 2 parts of sugar would give 1 part of alcohol. If, therefore, the grape juice should be found upon analysis capable of producing a wine with only 8% of alcohol, instead of its normal amount, say, of 16% after fermentation for every 100 parts of wine to be manufactured, 16 parts of sugar would have to be added. When the amount of free acid in the must exceeds 6 parts in 1,000, powdered marble is added, in the proportion of 50 parts of marble for every 60 parts of acid in excess. This method is inapplicable if the acid exists as acetic.

By Gall's method, when the free acid in the must exceeds 0·6%, the juice is diluted with water to that strength. In this case the percentage of sugar will also have been reduced. Gall believed a normal must should have the following composition:

Sugar	24·0%
Free acid	0·6%
Water	75·4%

One hundred parts by weight of such a must would therefore contain 24 parts of sugar, 0·6 part of free acid, and 75·4 parts of water. If by examination a sample of grape juice should be found to contain, say, 16·7% of sugar and 0·8% of free acid, to bring it up to Gall's standard, it would be necessary to add to every 1,000 lb. of such juice 153 lb. sugar and 180 lb. of water.

Grape sugar made from starch and dilute sulphuric acid is usually employed for this purpose, but such sugar has the objection of containing large quantities of dextrin, the presence of which injures the keeping power of the resulting wine. The wine produced by Gall's plan is said to be very pleasant, and not devoid of natural bouquet. Sometimes the wine maker adds a flavoring material to it. The process seems best adapted for those musts which are poor in sugar, but contain an excess of free acid. The removal of this may also be satisfactorily accomplished by the use of neutral

tartrate of potash. Among other methods practiced for increasing the alcoholic content of wine, is that of submitting it to a temperature at or below freezing, whereby a considerable quantity of its water becomes congealed, and may be separated along with some tartar, and coloring and albuminous matters, which are precipitated by the cold. Owing to the removal of these last from the wine, it is not so liable to undergo a second fermentation, while the abstraction of part of its water, of course, makes it richer in alcohol.

Gypsum is also frequently added to wines for the purpose of withdrawing some of their water, and therefore of increasing their strength. This it does, but only to a trifling extent. At the same time, it should be remembered that its addition to wine gives rise to the formation of soluble sulphate of potash, a bitter and active purgative, and wholly or partly removes the tartaric acid and the phosphates. Dupré and Thudichum have shown by experiment that this practice of plastering, as it is called, also reduces the yield of the liquid, as a considerable part of the wine mechanically combines with the gypsum and is lost.

Another reprehensible practice is the addition to the wine of brandy or of alcohol.

General Formulæ for the Preparation of Imitation Wines.—1. From ripe saccharine fruits.—Take of the fruit, 4 to 6 lb.; clear soft water, 1 gal.; sugar, 3 to 5 lb.; cream of tartar (dissolved in boiling water), 1¼ oz.; brandy, 2 to 3%; flavoring as required. If the full proportions of fruit and sugar are used, the product will be good without the brandy, but better with it. 1½ lb. raisins may be substituted for each pound of sugar.

In the above manner are made the following wines: Gooseberry wine, currant wine (red, white, or black), mixed fruit wine (currants and gooseberries, or black, red, and white currants; ripe black heart cherries and raspberries (equal parts), a good family wine; cherry wine, colepress's wine (from apples and mulberries, equal parts), elder wine, strawberry wine, raspberry wine, mulberry wine, whortleberry or bilberry wine; blackberry wine, damson wine, morella wine, apricot wine, apple wine, grape wine, etc.

2. From dry saccharine fruit (such as raisins). —Take of the dried fruit, 4½ to 7½ lb.; clear soft water, 1 gal.; cream of tartar (dissolved), 1 oz.; brandy, 1½ to 4%. Should the dried fruit employed be at all deficient in saccharine matter, 2 to 3 lb. of it may be omitted, and half that quantity of sugar or two- thirds of raisins added. In the above manner are made date wine, fig win, raisin wine, etc.

3. From acidulous, astringent, or scarcely ripe fruits, or those which are deficient in saccharine matter.—Take of the picked fruit, 2½ to 3½ lb.; sugar, 3½ to 5½ lb.; cream of tartar (dissolved), ½ oz.; water, 1 gal.; brandy, 2 to 6%.

In the above manner are made gooseberry wine, bullace wine, damson wine.

4. From footstalks, leaves, cuttings, etc.—By infusing them in water, in the proportion of 3 to 6 lb. to the gal., or q. s. to give a proper flavor, or to form a good saccharine liquid; and adding 2½ to 4 lb. of sugar to each gal. of strained liquor. One and a half lb. of raisins may be substituted for each lb. of sugar.

In the above manner are made grape wine (from the pressed cake of grapes), English grape wine, rhubarb wine (from garden rhubarb), celery wine, etc.

5. From saccharine roots and stems of plants.—Take of the bruised, rasped, or sliced vegetable, 4 to 6 lb.; boiling water, 1 gal.; infuse until cold, press out the liquid, and to each gal. add of sugar 3 to 4 lb.; cream of tartar, 1 oz.; brandy, 2 to 5%. For some roots and stems the water must not be very hot, as they are thus rendered troublesome to press.

In the above manner are made beet-root wine, parsnip wine, turnip wine, etc.

6. From flowers, spices, aromatics, etc.—These are prepared by infusing a sufficient quantity of the bruised ingredient for a few days in any simple wine (as that from sugar, honey, raisins, etc.), after the active fermentation is complete, or, at all events, a few weeks before racking them.

In the above manner are made clary wine (muscatel) (from flowers, 1 qt. to the gal.); cowslip wine (from flowers, 2 qt. to the gal.); elder flower wine (flowers of white berried elder, ¾ pt., and lemon juice, 3 fl. oz. to the gal.); ginger wine (1¼ oz. ginger to the gal.); orange wine (1 dozen sliced oranges per gal.); lemon wine (juice of 12 and rinds of 6 lemons to the gal.); spruce wine (¼ oz. of essence of spruce per gal.); juniper wine (berries, ¾ pt. per gal.); peach wine (4 or 5 sliced, and the stones broken, to the gal.); apricot wine (as peach wine, but with more fruit); quince wine (12 to the gal.); rose clove gillyflower, carnation, lavender, violet, primrose, and other flower wines (distilled water from the flowers, 1½ pt., or flowers 1 pt. to the gal.); mixed fruit wine; pine apple wine; cider wine; elder wine; birch wine (from the sap, at the end of February or beginning of March); sycamore wine (from the sap); malt wine (from strong wort); and the wines of any of the saccharine juices of ripe fruit.

7. From saccharine matter.—Take of sugar, 3 to 4 lb., cream of tartar, ½ oz.; water, 1 gal.; honey, 1 lb.; brandy, 2 to 4 per cent. A handful of grape leaves or cuttings, bruised, or 1 pt. of good malt wort, or mild ale, may be substituted for the honey. Chiefly used as the basis for other wines, as it has little flavor of its own.

In all the preceding formulæ lump sugar is intended when the wines are required very pale, and good Muscovado sugar when this is not the case. Some of the preceding wines are improved by substituting good cider, perry, or pale ale or malt wort, for the whole or a portion of the water. Good porter may also be advantageously used in this way for some of the deep colored red wines. When expense is no object, and very strong wines are wanted, the expressed juices of the ripe fruits, with the addition of 3 or 4 lb. of sugar per gal., may be substituted for the fruit in substance, and the water.

Management of Wine. — The remarks arranged under this heading are more particularly intended for the use of the dealer, the publican, and the private individual; as those which precede it are for the wine maker; matters common to each class will, however, be found in both sections of the present article.

Age.—The sparkling wines are in their prime in from eighteen to thirty months after the vintage. Thin wines, of inferior growths, should be drank within twelve or fifteen months, and be preserved in a very cool cellar. Sound, well fermented, full bodied still wines

are improved by age, with reasonable limits, provided they be well preserved from the air, and stored in a cool place having a pretty uniform temperature.

Bottling.—The secret of bottling wine with success consists in the exercise of care and cleanliness. The bottles should be sound, clean and dry, and free from the least mustiness or other odor. The corks should be of the best quality, and immediately before being placed in the bottles should be compressed by means of a cork squeezer, or of one of the numerous machines made for this purpose. For superior or very delicate wines, the corks are sometimes prepared by placing them in a copper or tub, covering them with weights to keep them down, and then pouring over them boiling water holding a little pearlash in solution. In this liquid they are allowed to remain for twenty-four hours, when they are well stirred about in the liquid, drained and reimmersed for a second twenty-four hours in hot water, after which they are well washed and soaked in several successive portions of clean and warm rain water, drained, dried out of contact with dust, put into paper bags, and hung up in a dry place for use. Many wine merchants, however, disapprove of this course, and merely dip the corks in clean cold water before inserting them in the bottles. The wine should be clear and brilliant, and if it be not so, it must undergo the process of fining before being bottled. The bottles, corks and wine, being ready, a fine clear day should be preferably chosen for the bottling, and the utmost cleanliness and care should be exercised during the process. Great caution should also be observed to avoid shaking the cask, so as not to disturb the bottoms. The remaining portion that cannot be drawn off clear should be passed through the wine bag, and, when bottled, should be set apart as inferior to the rest; or the lees are collected in a cask kept for the purpose, and the clear wine resulting from their subsidence is used for filling up casks about to be fined. The coopers, to prevent breakage and loss, place each bottle, before corking it, in a small bucket or boot having a bottom made of soft cork or leather, which is strapped on the knee of the bottler. The bottlers seldom break a bottle, though they flog in the corks very hard. The bucket or boot is now very largely supplanted by Gervaise's corking machine, an apparatus which first submits the cork to great pressure, and then immediately afterward drives it firmly into the neck of the bottle, in which, owing to its subsequent expansion, it fits very closely and perfectly. When the process of bottling is complete, the bottles of wine are stored in a cool cellar on their sides, but on no account in an upright position. Sometimes they are placed in damp straw, or in sweet, dry sawdust or sand.

Alcoholizing.—Alcohol is frequently added to weak or vapid wines, to increase their strength or to promote their preservation. In Portugal, 1/6 of alcohol is commonly added to port before shipping it for England, as without this addition it generally passes into the acetous fermentation during the voyage. A little alcohol is also usually added to sherry before it leaves Spain. The addition of alcohol to wine injures its proper flavor, and hence it is chiefly made to port, sherry, and other wines, whose flavor is so strong as not to be easily injured. Even when alcohol is added to wines of the latter description, they require to be kept for some time to recover their natural flavor.

Cellaring.—A wine cellar should be dry at bottom, and either covered with good hard gravel or be paved with flags. Its gratings or windows should open toward the north, and it should be sunk sufficiently below the surface to insure an equable temperature. It should also be sufficiently removed from any public thoroughfare so as not to suffer vibration from the passing of carriages. Should it not be in a position to maintain a regular temperature, arrangements should be made to apply artificial heat in winter and proper ventilation in summer. The temperature should range from 55° to 65° F. For Burgundies the former temperature is the more suitable; for ports, sherries and strong wines, the latter temperature.

Decanting.—In decanting wine, care must be taken not to shake or disturb the crust when moving it about or drawing the cork, particularly of port wine. Never decant wine without a wine strainer, with some clean fine cambric in it, to prevent the crust and bits of cork going into the decanter. In decanting port wine, do not drain it too close; as there are generally two thirds of a wineglassful of thick dregs in each bottle, which ought to be rejected. In white wine there is not much deposit; but it should nevertheless be poured off very slowly, the bottle being raised gradually.

Detartarization.—Rhenish wines, even of the best growths, and in the finest condition, besides their tartar, contain a certain quantity of free tartaric acid, on the presence of which many of their distinctive properties depend. The excess of tartar is gradually deposited during the first years of the vatting, the sides of the vessels becoming more and more encrusted with it; but, owing to the continual addition of new wine and other causes, the liquid often gains such an excess of free tartaric acid as to acquire the faculty of redissolving the deposited tartar, which thus again dissappears after a certain period. The taste and flavor of the wine are thus exalted, but the excess of acid makes the wine less agreeable, and probably less wholesome.

Under these circumstances the best corrective is pure neutral tartrate of potash. When this salt, in concentrated solution, is added to an acid wine, the free acid combines with the neutral salt, and separates from the liquid under the form of the sparingly soluble bitartrate of potash. If to 100 parts of a wine which contains 1 part of free tartaric acid we add 1½ parts of neutral tartrate of potash, there will separate on repose at 70° to 75° F., 2 parts of crystallized tartar; and the wine will then contain only ½ part of tartar dissolved, in which there are only 0·2 part of the original free acid; 0·8 part of the original free acid having been withdrawn from the wine. This method is particularly applicable to recent must and to wines which contain little, if any, free acetic acid; when this last is present, so much acetate of potash is formed as occasionally to vitiate the taste of the liquid.

Fining.—Wine is clarified in a similar manner to beer. White wines are usually fined by isinglass. The quantity of isinglass varies with the quality and condition of the wine, and is regulated by the experience of the cellarman. Stout wines require a larger amount than thin

ones. Even with stout ones it ought not to exceed ½ oz. to the hogshead. The Rhenish wines do not require more than ¼ oz., and the hocks still less. The choicest Russian isinglass only should be employed. It should be dissolved in cold water, and thinned with wine. Red wines are generally fined with the whites of eggs, in the proportion of 15 to 20 to the pipe. Sometimes, but rarely, hartshorn shavings, or pale sweet glue, is substituted for isinglass.

Flatness.—This is removed by the addition of a little new brisk wine of the same kind; or by rousing in 2 or 3 lb. of honey; or by adding 5 or 6 lb. of bruised sultana raisins and 3 or 4 qt. of good brandy, per hogshead. By this treatment the wine will usually be recovered in about a fortnight, except in very cold weather. The process may be expedited, if a tablespoonful or two of yeast be added, and the cask removed to a warmer situation.

Insipidity. See Flatness.

Maturation.—The natural maturation or ripening of wine and beer by age depends upon the slow conversion of the sugar which escaped decomposition in the gyle tun or fermenting vessel into alcohol. This conversion proceeds most perfectly in vessels which entirely exclude the air, as in the case of wine in bottles; as when air is present, and the temperature sufficiently high, it is accompanied by slow acetification. This is the case with wine in casks, the porosity of the wood allowing the very gradual permeation of the air. Hence the superiority of bottled over draught wine or that which has matured in wood. Good wine, or well fermented beer, is vastly improved by age when properly preserved; but inferior liquor, or even superior liquor, when preserved in improper vessels or situations, becomes acidulous from the conversion of its alcohol into vinegar. Tartness or acidity is consequently very generally, though wrongly, regarded by the ignorant as a sign of age in liquor. The peculiar change by which fermented liquors become mature or ripe by age is termed the insensible fermentation. It is the alcoholic fermentation impeded by the presence of the already formed spirit in the liquor, and by the lowness of the temperature.

Mould or fungus is very frequently produced by keeping the wine in too warm a cellar, or in a cask not filled to the bung hole, or else in one from which the bung has been left out. As it forms mostly on weak wines, its presence may be referred to a deficiency of alcohol.

The best method for its removal is either burning sulphur in a partially filled cask, or drawing off the wine into a fresh cask, in which sulphur has been previously burnt. It is advisable that wines so treated should be drunk as soon as possible.

Wine sometimes has an unpleasant musty taste, which it has acquired from being put into a dirty cask, or into one that has been unused for some time. This bad flavor, which is known as caskiness, may generally be removed by vigorously agitating the wine for some time with a little sweet, olive, or almond oil. The cause of the bad taste is the presence of an essential oil, which the fixed oil combines with and carries to the surface, whence it may be skimmed off, or the wine lying under it may be drawn off. A little coarsely powdered and freshly burnt charcoal, or some slices of bread toasted until they become black, or a little bruised mustard seed, sometimes effects the removal of the objectionable taste.

Ripening.—To promote the maturation or ripening of wine, various plans are adopted by the growers and dealers. One of the safest ways of hastening this, especially for strong wines, is not to rack them until they have stood 15 or 18 months upon the lees; or, whether crude or racked, keeping them at a temperature ranging between 55° and 65° F., in a cellar free from draughts and not too dry. Full or heavy sherries or ports, when bottled and treated in this manner, ripen very quickly in a temperate situation.

Racking.—Racking should be performed in cool weather, and preferably early in the spring. A clean siphon, well managed, answers better for this purpose than a cock or faucet. The bottoms, or thick portion, may be strained through a wine bag, and added to some other inferior wine.

Ropiness, Viscidity; *Graisse.*—This arises from the wine containing too little tannin or astringent matter to precipitate the gluten, albumen, or other azotized substance, occasioning the malady. Such wine cannot be clarified in the ordinary way, because it is incapable of causing the coagulation or precipitation of the finings. The remedy is to supply the principle in which it is deficient. M. François, of Nantes, prescribes for this purpose the bruised berries of the mountain ash in the proportion of 1 lb. to the barrel. A little catechu, kino, or, better still, rhatany, or the bruised footstalks of the grape, may also be conveniently and advantageously used in the same way. For pale white wines, which are the ones chiefly attacked by the malady, nothing equals a little pure tannin or tannic acid dissolved in proof spirit.

Second Fermentation; *La-pousse.*—Inordinate fermentation, either primary or secondary, in wine or any other fermented liquid, may be readily checked by sulphuration, or by the addition of sulphur, mustard seed, or sulphite of lime. The latter must, however, be used with discretion.

Sparkling, Creaming and Briskness.—These properties are conveyed to wine by racking it into closed vessels before the fermentation is complete, and while there still remains a considerable portion of undecomposed sugar. Wine which has lost its briskness may be restored by adding to each bottle a few grains of white lump sugar or sugar candy. The bottles are afterward inverted, by which means any sediment that forms falls into the necks, when the corks are partially withdrawn, and the sediment is immediately expelled by the elastic force of the compressed carbonic acid. If the wine remains muddy, a little solution of sugar and finings are added, and the bottles are again placed in a vertical position, and, after two or three months, the sediment is discharged as before.

Ages of Different Wines when at Their Prime. See also the Management of Wine above.—The age named below for each wine will be found to be that at which it possesses its fullest flavor and when it will be best to drink it.

Port	20	years.
Madeira	10	years.
Sherry	10	years.
Red Madeira	6	years.

Madeira-malmsey	5	years.
Callavella	4	years.
Malaga	3	years.
Muscatel	3	years.
Red hermitage	20	years.
White hermitage	20	years.
Roussillon	20	years.
Rivesaltes	20	years.
Banyuls	20	years.
Collioure	15	years.
Salces	10	years.
La Palme	10	years.
Sigean	8	years.
Carcassone	8	years.
Beziers	8	years.
Lunel	8	years.
Champagne	6	years.
Montpellier	5	years.
Frontignan	5	years.

Acid Taste of Wines, to Remove.—Neutralize the excess of acid by powdered chalk.

Alcoholizing Wine. See *Management of Wine.*

Apple Wine.—1. Finest cider, 60 gal.; brown sugar, ½ cwt.; bitter almonds, ½ oz. Mix the cider and sugar, and ferment; then rack the mixture, and put into the cask the almonds, with 16 or 18 cloves, and 3 or 4 pieces of bruised ginger. When fine, bottle it and keep it in a cool place. The addition of a small piece of lump sugar to each bottle will make the cork fly out, as from champagne; but do not add this unless you have a very cold cellar to keep it in.

2. Forty lb. sugar, 15 gal. cider. The cider must be pure and made only from really ripe, sound apples (this is important). If the wine is to be quite sweet, add another 10 lb. of sugar, and put all into the cider, letting it stand till dissolved. Put the liquor into a cask but leave it unfilled to the extent of 2 gal. Put the cask into a cool position, with the bung out for forty-eight hours. After this bung it up, but let there be a small vent somewhere—in the bung would do—until the fermentation is over. Then bung up securely, and the wine will be ready for consumption in twelve months. There is no racking required in the manufacture of this wine. To remain in the cask twelve months. Make this in January or February.

Apricot Wine.—Twelve lb. ripe apricots, 6 oz. loaf sugar to each qt. liquor. Wipe the apricots, cut them in pieces and let them boil in 2 gal. water. After boiling, let them simmer till the liquor is strongly impregnated with the flavor of the fruit. Strain through a hair sieve, and put 6 oz. lump sugar to every qt. liquor. Boil again, skim very carefully, and as soon as no more scum appears, put it into an earthen pan. Bottle next day if it is quite clear, and put 1 lump of sugar into each bottle. It should be fine wine in six months. Two hours to boil. Make this in August or September.

Balm Wine.—1. Into 8 gal. of water put 20 lb. of moist sugar; boil for two hours, skimming thoroughly; then pour into a tub to cool; place 2½ lb. of balm tops, bruised, into a barrel with a little new yeast; when the liquor is cold pour it on the balm; stir it well together, and let it stand twenty-four hours, stirring it frequently; then close it up tightly at first, and more securely after fermentation has quite ceased; when it has stood two months, bottle off, putting a lump of sugar into each bottle; cork down well and keep in bottle at least a year.

2. Put a peck of balm leaves into an open tub; pour on them 4 gal. of boiling water; cover up the tub and let them infuse for twelve or fourteen hours; strain the liquor at the end of that time through a hair sieve, and to every gallon add 2 lb. of good moist sugar, stirring well for twenty minutes; take the whites of 4 eggs, whisk them over the fire in a saucepan; remove it from the fire as the scum rises, and skim the latter off; then add it to the liquor; boil the whole for three quarters of an hour, letting it work three or four days before you tun it; bung down, and when fine, bottle it off; in six or eight months it will be fit to drink.

Bilberry Wine.—The fruit should be picked on a very dry day, when it is quite ripe. The leaves and stalks must be carefully removed from the berries and the fruit, then weighed. To 4 gal. of fruit allow either 6 gal. of cold water or else 3 gal. of water and 3 gal. of cider, and 10 lb. of good moist sugar; let all these ingredients ferment in an open tub until working is over; then add ½ gal. of brandy, a handful of lavender and rosemary leaves mixed, 2 oz. of powdered ginger, and 2 oz. of powdered tartar; let the liquor rest after this addition for forty-eight hours, then strain very carefully through a hair sieve into a perfectly clean cask, laying the bung lightly on the bung hole until the working is quite over; and no hissing sound is heard; then close down quite tightly, and bottle off at the end of three months; keep six or eight months in bottle before use.

Blackberry Wine.—1. To 1 gal. of mashed blackberries add a quart of boiling water; let it stand for twenty-four hours, or nearly as long, then strain through a coarse bag or towel, adding 3 qt. of water and 2 lb. of brown sugar to each gallon of the mixture, making equal parts of water and juice; mix well, then put in demijohns, stone jugs or a tight, clean keg; close partially and put in a cool place; if in a warm place or left entirely open it will sour; if stopped entirely tight it will burst the vessel—but cork left loosely in; let it stand until fermentation ceases, which will be about October; then bottle, and this makes excellent wine and a fine medicinal drink for summer affections.

2. The following is said to be an excellent receipt for the manufacture of superior wine from blackberries: Measure your blackberries, and bruise them; to every gallon add 1 qt. of boiling water; let the mixture stand twenty-four hours, stirring occasionally; then strain off the liquor into a cask; to every gallon add 2 lb. of sugar; cork tight, and let stand about one year, and you will have wine fit for use, without any further straining or boiling. This wine is very highly recommended for household use.

Bottling of Wine. See *Management of Wine.*

Catawba Champagne.—Twenty gal. Catawba, 1 qt. Cognac brandy, and 2 gal. champagne syrup.

Cellaring Wine. See *Management of Wines.* Also *Laying Down Wines*, below.

Champagne, Imitation.—

1. Prepared cider	25	gal.
Citric acid	5	drm.
Simple syrup	1¼	pt.
Water	1¼	gal.
Spirits (10 under proof)	2½	gal.
Tartaric acid	1¼	oz.

Let this stand twelve days, then fine and bottle, if it is frothing and sparkling; if not, add more acid; and fine again. Add to each bottle about 2 teaspoonsful of syrup, made by dissolving ½ lb. rock candy in 1 pt. white wine.

2. Cider, pale, 1 hogshead; spirit, 3 gal.; honey or sugar, 20 lb. Mix and allow to remain two weeks; then fine with skimmed milk, ½ gal. This will be very pale.

3. Cheap Champagne.—

Bordeaux	10	gal.
Rodenheimer or Hockheimer	10	gal.
Water	10	gal.
French spirit	1	gal.
Syrup	3	gal.

Made of 18 lb. sugar and 6 qt. water.

4. Champagne, Gooseberry.—Ferment together 5 gal. white gooseberries, mashed, with 4½ gal. water. Add 8 lb. sugar, 4½ lb. honey, 1 oz. finely powdered white tartar, 1 oz. dry orange and lemon peel, and ½ gal. white brandy. This will produce 9 gal. Before the brandy is added, the mixture must be strained and put into a cask.

5. *Champagne Liqueur.*—

Fine loaf sugar	13	lb.
Water	1½	gal.

Boil together. While boiling, add by degrees 3 qt. alcohol, 90%, filter. Add to the following compound:

6. Louis Röederer.—Mix the champagne liqueur with 11¼ gal. white wine; 1½ bottle cognac; 6 drops sulphuric ether, dissolved in the cognac.

7. Champagne, Syrup for.—Dissolve 12 lb. white sugar in 1 gal. water, and add the whites of 2 eggs. Heat until it candies. Strain through flannel.

Cherry Wine.—Take of cold soft water, 10 gal.; cherries, 10 gal.; ferment. Mix raw sugar, 30 lb.; red tartar, in fine powder, 3 oz.; add brandy, 2 or 3 qt. This will make 18 gals. Two days after the cherries have been in the vat, we should take out about 3 qt. of the cherry stones, break them and the kernels, and return them into the vat again.

Black Cherry Wine.—24 lb. of small black cherries, 2 lb. of sugar to each gal. of liquor.

Bruise the cherries, but leave the stones whole, stir well, and let the mixture stand 24 hours, then strain through a sieve, add the sugar, mix again, and stand another 24 hours. Pour away the clear liquor into a cask, and when fermentation has ceased, bung it closely. Bottle in 6 months' time. It will keep from 12 to 18 months.

Time.—To remain in the cask six months. Make this in July or August.

Claret.—

1. Prepared cider	30	gal.
Good port wine	6	gal.
Water	1½	gal.
Tartar	1½	lb.
Syrup	1½	pt.
Citric acid	2¼	drm.
Raisins	3	lb.

Color if desired with red sanders or red beet juice. Let it stand 10 to 12 days, rack.

2. Good cider and port wine, equal parts.

3. To each gallon of the last add cream of tartar (genuine) 3 drm., and the juice of one lemon.

4. To either of the preceding add French brandy, 2 oz.

5. Instead of port, use red cape or British port.

If the first three of the above are well mixed and fined down, and not bottled for a month or five weeks, they can scarcely be distinguished from good Bordeaux. A mixture of 4 parts of raisin wine with 1 part each of raspberry, and barberry or damson wine, also forms an excellent factitious claret.

Coca Wine.—This is a French preparation. Its strength is about 1 in 30, and the dose a wineglassful. Coca wine is, roughly speaking, about one-sixth of the strength of the official liquid extract (*Extractum Cocæ Liquidum* B. P., or *Extractum Erythroxyli Fluidum* U. S.). To obtain the liquid extract, coca leaves are exhausted by percolation (which differs from either decoction or infusion) with proof spirit. At the termination of the process, the strength should be adjusted so that 1 oz. = 1 of leaves. The process of percolation is as follows: The leaves are placed in a vessel very like an elongated funnel, closed at its base by a porous diaphragm. This funnel fits into a receiver, and a small tube passes up its outer side and enters it near the top, forming a means of communication between the two. Spirit is now poured on the leaves, and the percolator closed. As the percolate filters slowly through into the reservoir, the displaced air passes up the tube, and so maintains an equilibrium in both vessels. The virtue of the coca leaves lies principally in the presence of the alkaloid cocaine. This, in the dried leaves, is supposed to exist as an inert salt, similar to many of the cinchona alkaloids in bark.

Coloring Matters Used to Color Wine.—Various matters are largely employed to artificially heighten the colors of wines. The different spurious coloring matters can be detected by using a solution of lead acetate, and the precipitates formed give a good test by which the various colors can be determined.

1. Malva flowers or hollyhock produce, when steeped in spirits for 24 hours, or even when boiled with water, a very beautiful purple.

2. The pokeberry (the dark berries from the plant growing all over the United States) has a very dark red color.

3. Whortleberry, huckleberry, elderberry, blackberry and mulberry.

4. Cochineal gives a fine red color by boiling finely ground cochineal with cream of tartar.

5. Brazil wood, sanders wood and logwood. These woods are boiled in water, and the decoctions yield shades of color from red to blue.

6. Orchil produces a beautiful purple.

7. Red beets and carrots produce likewise a good color.

8. Indigo solution, neutralized by potash, produces a fine blue.

9. Annatto and extract of safflower produce a beautiful yellow.

10. Red cabbage produces a beautiful bluish red.

11. Turmeric is the most common color for yellow, as the spirit extracts all color immediately; as also quercitron bark.

12. Garacine (extract of madder) produces various shades of red.

13. Tincture of saffron (Spanish saffron) for yellow.

14. Blue vitriol, or solution of indigo, produces blue.

15. Burnt sugar produces a fine and permanent brown color for wines. It is best to boil down common sugar or loaf sugar nearly to dryness. It is then dissolved in hot water sufficient to make the consistency of syrup; and for the purpose of neutralizing it and making it a more permanent color, add to each gal. of sugar color, about 1 oz. liquid ammonia.

16. Green color for absinthe is prepared from a solution of extract of indigo and turmeric, dissolved in spirits.

17. Violet is obtained by a solution of extract of logwood and alum.

18. Alkanet root produces a fine blue red by macerating in alcohol.

19. Barwood acquires a dark wine red color by digesting in alcohol.

20. Brazil wood, by being macerated in alcohol, or by boiling for half hour, produces a deep red.

Spurious Coloring Matter.—

The following coloring matters give, with lead acetate, the following precipitates:

Pure red wine	gives	bluish gray.
Red poppy	"	dirty gray.
Elderberry	"	dirty green.
Bilberry	"	grayish green.
Privetberry	"	green.
Dwarf elder	"	bluish gray to violet in the fresh berries and fine green in the fermented extract.
Mallow flower	"	dark green.
Logwood	"	feeble dark blue.
Brazil wood	"	wine red.

The following colors, when present, give the following precipitates with alum and ammonium carbonate:

Pure red wine	gives	dirty green.
Red poppy	"	slate gray.
Elderberry	"	bluish gray.
Bilberry	"	bright violet.
Privetberry	"	bright green.
Dwarf elderberry	"	bright violet.
Mallow flower	"	bluish violet.
Logwood	"	dark violet.
Brazil wood	"	carmine red.

Cranberries can be made into wine in the same way as bilberries. In America the cranberry is largely cultivated, and forms a considerable article of commerce, a quantity of the fruit being exported. In the northern parts of Russia it is also very abundant.

Cowslip Wine.—To every gal. of water allow 3 lb. of lump sugar, the rind of 2 lemons, the juice of one, the rind and juice of 1 Seville orange, 1 gal. of cowslip pips. To every 4½ gal. of wine allow 1 bottle of brandy. Boil the sugar and water together for ½ hour, carefully removing all the scum as it rises. Pour this boiling liquor on the orange and lemon rinds, and the juice, which should be strained; when milk warm, add the cowslip pips or flowers, picked from the stalks and seeds; and to 9 gal. of wine 3 tablespoonfuls of good fresh brewers' yeast. Let it ferment three or four days, then put all together in a cask with the brandy; and let it remain for two months, when bottle it off for use. To be boiled ½ hour; to ferment three or four days; to remain in the cask two months. Make this in April or May.

Currant Wine.—Squeeze the currants through a coarse bag; have equal parts of water and juice, or ⅓ water, as taste may direct, and add 3 lb. of loaf sugar to each gal. of the mixture; mix well and bottle in stone jugs or demijohns; treat same way as blackberry wine—partially corked and keep in a cool place. Some keep a bottle of the mixture to fill up the vessels as they effervesce, but it is not always necessary. Bottle in October, when fermentation ceases; this makes a beautiful and delicious wine, and improves with age.

Red Currant Wine (with Raspberries.)—Ten gal. of red currant juice, 1 pt. of raspberry juice, 20 gal. of water, 18 lb. of finely sifted loaf sugar. Put the ingredients together and let them stand until the sugar is dissolved, then put the liquor into a cask and bung lightly for the air to aid in the fermentation. Let it cease fermenting, then bung tightly. Bottle in a year's time, using sound corks and sealing them. It will be in excellent condition in three months.

Currie Wine.—Curric powder, 5 oz.; white wine, 1 gal. Digest for one week and strain.

Cyprus.—Muscatel (very old), 25 liters; alcohol, 85%, 5 liters; white wine (dry and alcoholic), 64 liters; infusion of walnuts, 1 liter; white sugar, 2 kilos.; water, 1 liter. Mix the different wines together; add the alcohol and the infusion of walnuts; dissolve the sugar in the water, and boil till the solution becomes of a golden color; add it to the mixture with a little of the infusion of cloves.

2. *British Cyprus.*—From the juice of white elderberries, 1 qt., and Lisbon sugar, 4 lb., to water, 1 gal., together with ½ drm. each of bruised ginger and cloves. When racked add raisins and brandy, of each 2 oz.

Damson Wine.—

1. Water	12	gal.
Damsons (bruised)	8	gal.
Raw sugar	30	lb.

Ferment, then add—

Red tartar (dissolved)	6	oz.
Cloves (bruised)	¼	oz.

Let it stand until fine, then bottle.

2. Crush 20 lb. ripe damson plums; boil in 3 gal. water; press out the juice; add 6 lb. sugar; put in a barrel and let it ferment; then add after two weeks a little good brandy; bottle.

3. One gal. of boiling water to every 8 lb. of bruised fruit, 2½ lb. of sugar to each gal. of juice.

Well bruise the fruit and pour the boiling water on it; let it stand forty-eight hours. Then strain the mixture into a cask and put in the sugar. When fermentation ceases fill up the cask and bung closely. Bottle in ten months' time. It will be fit for use in a year, but improves with keeping. Time required,

about two years.

Detannation of Wines.—*The Formulary* recommends the following method for removing the tannin or astringent matter from sherry wine:

Sherry	7	pt.
White of egg	1	fl. oz.
Alcohol	1	pt.

Beat the white of egg to a froth and mix it with wine; heat to about 170° F., or until the albumen is coagulated. Then cool, add the alcohol, and after standing a few hours, filter clear through paper.

This wine is a much better menstruum and preservative medium for organic substances than sherry itself.

Detartarization of Wine. See *Management of Wine.*

Elder Wine.—

Alcohol, 90%	12½ gal.
Water	12½ gal.
Elderberries (juice of)	6¼ gal.
Loaf sugar	18¾ lb.
Port wine	2¼ gal.
Orange flower water	⅝ pt.

Allow it to stand one week; draw off.

Elderberry Wine.—1. Gather the berries when quite ripe, on a dry day; pick them off the stems, and bruise them with your hands. Strain the juice; let the liquor rest in glazed earthenware pans for twelve hours to settle. Allow to every pint of juice a 1½ pt. of water, and to every gallon of the mixed water and juice 3 lb. of good moist sugar. Put it over the fire in a large saucepan, and when it is ready to boil, clarify it with the whites of four eggs. Let it boil for an hour, and, when nearly cold, put in some yeast to work it; pour it into the cask, reserving some of the liquor to fill up the cask with, as it sinks with working. If you have about 10 gal. or so, it should be fit to bottle off in two months' time after it has been closed down. Keep at least a year in bottle.

2. Gather the berries when quite ripe, and in dry weather. Pick them clean; put them into a copper with ½ gal. of water, and keep up a slow fire until the berries sink, then strain the juice through a hair sieve, and to every gallon of it allow 3 gal. of soft water, and to every gallon of the mixed liquor 3 lb. of good moist sugar. Put back into the copper, and boil for an hour, skimming thoroughly; draw off into a tub, and, when it is about 70°, put a toast spread with yeast into it, and let it work for forty-eight hours, or longer if necessary; pour it or draw it off if you have a tap in your tub, as should be the case, into the cask which is to hold it, and if you have 18 gal. of liquor, add 1 oz. of cloves, 2 oz. of allspice, 2 oz. of Jamaica ginger, and 1 oz. of sweet almonds, all bruised. Bung very slightly until fermentation is quite over; then close down tightly and tap in three months.

3. Old recipe: Put the ripe picked over berries into an earthen pot; put this into a copper with sufficient water to come up about two-thirds of the height of the pot, which is about as far as the berries should reach inside; be careful that no water touches them. Make a gentle fire, and keep the pot in the water till it is quite hot; then take it out. Pour the berries into a coarse cloth, strain the juice, and put it into a large saucepan; to every quart of juice allow a pound of good moist sugar; let it boil, and skim well. It should boil until rather thick, then pour it into a jar. Put 60 lb. of raisins into a cask, and fill it up with water; let it stand for a fortnight; stir it well every day; then pour off the liquor into a clean cask that just holds it. It should stand until it has done hissing; then bung it down close, and stand until fine. To every gallon of this liquor, allow half a pint of the elder sirup; mix well, and when it has fined down, rack off into another cask; bottle off after three months.

4. Chop a quantity of Malaga raisins quite fine; allow 1 qt. of water to every lb. of raisins, and put raisins and water into an open tub; cover over with a double cloth, and let it stand for nine days, stirring up each day. Then draw off the liquor as long as it will run, and press the raisins to get out the remainder of the juice; mix all together in a barrel. To every gal. of liquor allow 1 pt. of the juice of elderberries, prepared simply by mashing the berries with the hands, and straining off the juice. Stop down close, and stand for six weeks, then draw off the fine liquor, and to every gal. add ½ lb. of moist sugar. Stand again until quite fine, and then bottle off. Keep in a cool cellar for use.

5. Take 30 lb. of Malaga raisins, add 8 gal. of water to them, and allow to steep for twelve days; draw off the liquor, and put it into a copper with 2 gal. of elderberry juice; boil for ten minutes, removing all scum as it rises; then add 7 lb. of moist sugar, ½ oz. of allspice, ½ oz. of cloves, and 2 oz. of Jamaica ginger, all well bruised; boil again for an hour, skimming thoroughly; draw it off and float some toast covered with yeast in it; leave it to work for two or three days, then pour into a clean cask, and, when all fermentation is over, bung down tightly. If made the end of August or in September, this wine would be ready to tap about Christmas, and should be bottled in January or March.

6. Allow 3 qt. of elderberries, which are quite ripe and carefully picked over, to every gal. of water; boil, skimming well, until the berries break, then strain the liquor, and to every gal. allow 3 lb. of moist sugar, and to every 4 gal. add 2 oz. of bruised ginger, 2 oz. of cloves, and 2 oz. allspice; boil for an hour; work with yeast when nearly cold; cask it the third day, and when all working is over, bung down.

7. To every gal. of berries allow a gal. of water; steep in a tub for four days, bruising well each day. Squeeze the pulp, and strain off the juice. To every gal. add 3 lb. of brown sugar, and spices in the same proportion as in the above recipe; tie the spice in a muslin bag; boil all the ingredients for an hour; work with yeast when nearly cold; then pour into a well cleaned cask, and bung down when the fermenting operation has quite ceased. Bottle off in two or three months. Into every bottle put a lump of white sugar and a little brandy.

8. To 1 gal. of berries add 3 qt. of water; bruise in a tub, and stand for three days. To every qt. of liquor allow 1 lb. of moist sugar, 1 oz. of ginger, and 1 oz. of cloves, both bruised (the spice should be put into muslin bags); put all together into a perfectly clean vessel, and boil for one hour; then pour into an earthenware pan; when cool enough to dip in the finger, put in a tablespoonful of brewers' yeast; let it work three days, then skim and put in a

small cask just large enough to hold the amount. Keep out the air for three weeks, but do not bung down close until that period has elapsed. Tap in two months to test it; if fine, bottle off.

Elder flower wine is made from the flowers in this manner: 1. Gather the flowers on a dry day; remove all stalks, and to every qt. of flowers allow 1 gal. of water and 3 lb. of loaf sugar; boil the sugar and water for a quarter of an hour; then pour it on the flowers, and let it work for three days; then strain the wine carefully through a hair sieve, and put it into a cask. To every 5 gal. of wine add ½ oz. of isinglass, dissolved in cider, and 3 eggs (whites only) beaten up; close up the cask, and stand six months before bottling off.

2. Boil 18 lb. of powdered loaf sugar in 6 gal. of spring water; beat up the whites of 2 eggs, and add; skim very thoroughly, and put in a ¼ of a peck of elder flowers, picked from their stems; take off the fire, and stir until cool, then add 4 tablespoonfuls of yeast and 6 spoonfuls of lemon juice, strained and free from pips; mix well with the liquor by stirring twice daily for four days. Stone 6 lb. of Malaga raisins, and put them into a well cleaned out cask; pour the wine upon them. Stop up the cask closely, and keep it in a rather warm place. If made in July or August, bottle off in February or March. This wine, when well made, very much resembles Frontignac.

Fig Wine.—Figs are largely employed, especially in Algeria, for the production of fictitious wine. For this purpose figs from Asia Minor are preferred on account of their relative cheapness and richness in sugar. When the fruit is treated with a suitable quantity of tepid water, acidified with tartaric acid, fermentation rapidly commences, resulting in the production of a vinous liquid of about 8° alcoholic strength, and so inexpensive that it defies all competion of genuine grape wine, Algerian or otherwise. Fig wine cannot be distinguished either by taste or the ordinary methods of analysis from genuine grape wine, especially when it is mixed with a proportion of the latter. The detection of fig wine, however, is rendered comparatively easy by the fact that it contains mannitol. In order to separate the mannitol, 100 c. c. of fig wine are evaporated to a syrup, which is allowed to stand in a cool place for twenty-four hours. At the end of this time the residue will have solidified, well defined groups of crystals being formed. The crystals are washed with cold alcohol of 85% strength in order to remove impurities. The residue is mixed with animal charcoal and extracted with boiling 85% alcohol and filtered. The alcoholic solution yields on evaporation a crystalline mass of mannitol, which may be recognized by its physical and chemical properties. Certain white wines from the Gironde district, as well as raisin and some other wines, contain mannitol, but only to the extent of a few decigrammes per lit.; while fig wine contains from 6 to 8 grm. per lit. By a determination of the mannitol it is possible to detect an adulteration of normal Algerian wine with one half or even one fourth of fig wine.

To Fine Wines.—There are various modes of fining wine; eggs, isinglass, gelatine and gum arabic are all used for the purpose. Whichever of these articles is used, the process is always the same. Supposing eggs (the cheapest) to be used: Draw a gal. or so of the wine and mix 1 qt. of it with the whites of 4 eggs, by stirring it with a whisk; afterward, when thoroughly mixed, pour it back into the cask through the bunghole, and stir up the whole cask in a rotary direction with a clean split stick inserted through the bunghole. Having stirred it sufficiently, pour in the remainder of the wine drawn off, until the cask is full; then stir again, skimming off the bubbles that rise to the surface. When thoroughly mixed by stirring, close the bunghole, and leave it to stand for three or four days. This quantity of clarified wine will fine 13 doz. of port or sherry. The other clearing ingredients are applied in the same manner, the material being cut into small pieces, and dissolved in the qt. of wine, and the cask stirred in the same manner.

To Lay Down Wine.—Having carefully counted the bottles, they are stored away in their respective bins, a layer of sand or sawdust being placed under the first tier and another over it; a second tier is laid over this, protected by a lath, the head of the second being laid to the bottom of the first; over this another bed of sawdust is laid, not too thick, then another lath; and so on till the bin is filled. Wine so laid in will be ready for use according to its quality and age. Port wine, old in the wood, will be ready to drink in five or six months; but if it is a fruity wine, it will improve every year. Sherry, if of good quality, will be fit to drink as soon as the sickness (as its first condition after bottling is called) ceases, and will also improve; but the cellar must be kept at a perfectly steady temperature, neither too hot nor too cold, but about 55° or 60°, and absolutely free from draughts of cold air.

To Fine White Wine.—To fine 30 gal. white wine the whites of 3 eggs, will be required with the addition of ½ an egg shell reduced to powder, and a tablespoonful of salt. Beat up all together with a little of the wine and then pour gradually into the wine, stirring constantly.

To Fine Red Wines.—The operation is carried on in the same manner. To lighten up a wine add 6 eggs and a handful of salt, use the whites, yelks, and shells.

Flatness of Wine. See *Management of Wine*.

Ginger Wine.—1. This is an excellent stomachic, and is very popular in England as a cheap substitute for a grape wine:

Sugar	12 lb.
Water	3½ gal.
Ginger	4 oz.

Boil them together for half an hour; when cooled to 75 degrees, add the rinds of 6 lemons and some good yeast; let it ferment for ten or fourteen days, then add 1 pint of brandy and bottle it for use.

2. To 9 gal. of water allow 27 lb. of loaf sugar, 9 lemons, 12 oz. of bruised ginger, 3 tablespoonfuls of yeast, 2 lb. of raisins stoned and chopped, 1 pt. of brandy.

Boil together for one hour in a copper (let it previously be well scoured and beautifully clean) the water, sugar, lemon rinds and bruised ginger. Remove every particle of scum as it rises, and when the liquor is sufficiently boiled, put it into a large tub or pan, as it must not remain in the copper. When nearly cold, add the yeast, which must be thick and very fresh, and the next day, put all in a dry cask

with the strained lemon juice and chopped raisins. Stir the wine every day for a fortnight; then add the brandy, stop the cast down by degrees, and in a few weeks it will be fit to bottle. Sufficient to make 9 gal. of wine. The best time for making this wine is either in March or September.

Gooseberry Wine, Effervescing.—To every gallon of water allow 6 lb. of green gooseberries, 3 lb. lump sugar.

This wine should be prepared from unripe gooseberries, in order to avoid the flavor which the fruit would give to the wine when in a mature state. Its briskness depends more upon the time of bottling than upon the unripe state of the fruit, for effervescing wine can be made from fruit that is ripe as well as that which is unripe. The fruit should be selected when it has nearly attained its full growth, and consequently before it shows any tendency to ripen. Any bruised or decayed berries and those that are very small should be rejected. The blossom and stalk ends should be removed, and the fruit well bruised in a tub or pan, in such quantities as to insure each berry being broken without crushing the seeds. Pour the water (which should be warm) on the fruit, squeeze and stir it with the hand until all the pulp is removed from the skin and seeds, and cover the whole closely for twenty-four hours; after which strain it through a coarse bag, and press it with as much force as can be conveniently applied, to extract the whole of the juice and liquor the fruit may contain. To every 40 or 50 lb. of fruit 1 gal. more of hot water may be passed through the marc, or husks, in order to obtain any soluble matter that may remain, and be again pressed. The juice should be put in a tub or pan of sufficient size to contain all of it, and the sugar added to it. Let it be well stirred until the sugar is dissolved; and place the pan in a warm situation; keep it closely covered, and let it ferment for a day or two. It must then be drawn off into clean casks, placed a little on one side for the scum that rises to be thrown out, and the casks kept filled with the remaining must that should be reserved for that purpose. When the active fermentation has ceased, the casks should be plugged upright, again filled, if necessary, the bungs be put in loosely, and after a few days, when the fermentation is a little more languid (which may be known by the hissing noise ceasing), the bungs should be driven in tight, and a spile hole made, to give vent if necessary. About November or December, on a clear, fine day, the wine should be racked from its lees into clean casks, which may be rinsed with brandy. After a month, it should be examined to see if it is sufficiently clear for bottling; if not, it must be fined with isinglass, which may be dissolved in some of the wine; 1 oz. will be sufficient for 9 gal. In March or April, or when the gooseberry bushes begin to blossom, the wine must be bottled, in order to insure its being effervescing. Make this the end of May or the beginning of June, before the berries ripen.

Grape Wine.—1. Ripe grapes.—Mash sound, ripe grapes well with your hands in an earthen pan, or if not with your hands, with a perfectly tasteless stick of wood. Do not crush the seeds; strain the liquor into a cask, gently squeeze the pulp, pouring the remainder of the juice into the cask (strained). Let it stand aside for a fortnight, then draw it off into another cask, covering up the bunghole with a piece of slate till all fermentation has ceased. Bottle in six months, cork and seal, and it will be drinkable in twelve months' time.

2. Grape Wine.—Ten lb. fresh grapes are put into a large jar or crock, 3 qt. boiling water poured over them, and when the water is cool enough to permit of it, squeeze the grapes well with the hand. After allowing the jar to remain 3 or 4 days covered with a cloth, press out the grapes, then add 5 lb. sugar. Allow it to remain for one week, skim and strain carefully, then bottle, corking loosely. After the fermentation is completed, strain and seal tightly.

3. Put 20 lb. of ripe grapes into a stone jar and pour on 6 qt. boiling water; when cooled sufficiently squeeze by hand. Cover jar with cloth, let stand for three days, then press out the juice; add 10 lb. crushed sugar. After standing a week, scum, strain and bottle, corking loosely. When fermentation is complete strain again and bottle, corking tightly. Lay on side in cool place.

British Hock, British Red Hock.—From cream of tartar, 1¼ oz.; tartaric acid, ½ oz. (both in very fine powder); juices of the purple plum, ripe apples, and red beet, of each (warmed), 5 pt.; lemon juice, 1 pt.; with white sugar, 2½ lb. per gal.

Honey Wine.—

Honey	20	lb.
Cider	12	gal.

Ferment, then add—

Rum	½	gal.
Brandy	½	gal.
Red or white tartar (dissolved)	6	oz.
Bitter almonds	½	oz.
Cloves	¼	oz.

This is also called mead wine.

Kola Wine.—

Kola nuts in course powder	1	oz.
Sherry wine	30	oz.

Macerate for eight days and filter.

This wine may also be made with roasted kola nuts, which give a better tasting preparation and it is none the worse for the addition of a little sugar.—*Dieterich in Phar. Central.*

Madeira Wine.—1. To 10 gal. prepared cider add 1 gal. Madeira wine; 3 qt. pure proof spirits; 1 qt. brandy; ¾ to 1 oz. tartaric acid; ¼ drm. oil bitter almonds cut in ½ pt. alcohol; 1½ lb. loaf sugar. Allow it to stand for two weeks; rack, fine and repeat if necessary.

2. Pale malt, ground, 4 bushels; boiling water, 44 gal.; infuse, strain off this while warm; take 24 gal. and add sugar candy, 14 lb., and cream of tartar, 3 oz.; when dissolved add yeast 2 lb.; ferment, keep skimming off the yeast and when the fermentation is nearly finished add raisin wine, 2½ gal.; brandy and sherry wine of each 2 gal.; rum, 1 qt.; bung it down for six or nine months. A second infusion of the malt may be made for beer.

3. Purified honey	15	oz.
Hop tops	¾	oz.
Alcohol, 90%	19½	oz.
French wine	4½	qt.

Add ¾ oz. tincture burned sugar. Filter.

Mead or Honey Wine.—Take 10 gal. of water,

2 gal. of strained honey, with 2 or 3 oz. of white Jamaica ginger root, bruised, and 2 lemons cut in slices. Mix all together and boil for half an hour, carefully skimming all the time. Five minutes after the boiling commences add 2 oz. of hops. When partially cold put it into a cask to work off. In about three weeks after working it will be fit to bottle. This is a wholesome and pleasant beverage, particularly grateful in summer when drunk mixed with water.

British Malmsey.—From sliced or grated parsnips, 4 lbs.; boiling water, 1 gal.; when cold press out the liquid, and to each gal. add of cream of tartar, ½ oz., and good Muscovado sugar, 3 lb.; ferment, rack and add of brandy, 3% to 5%. Good Malaga raisins may be substituted for the sugar.

Maturation of Wine. See *Management of Wine.*

Medicated Wines.—Dieterich, in a late issue of his *Pharmaceutische Manual*, gives a number of formulæ for the preparation of medicated wines. Few, if any, of these can be regarded as tipples, but all are peculiar for the fact that the wine from which they are made is detannated. We give a selection of the more important formulæ for articles which should be salable if put up in attractive form and brought before customers in a nice way.

Cascara Sagrada Wine.—

White gelatine, in strips	15	grn.
Distilled water	2½	drm.

Dissolve by the aid of heat, and add to—

Sherry wine	28	oz.

Shake well, set aside for some time, then add—

Tasteless fluid extract of cascara sagrada	1½	oz.
Sugar	1½	oz.

Set aside in a cool place for eight days, and filter.

A similar wine, not free from the bitter principle of the bark, may be made by macerating 1½ oz. of cascara sagrada and 1½ oz. of sugar in 30 oz. of sherry, for eight days, and filtering. A *Rhamnus frangula* wine can be made in the same way.

Cinchona Wine.—

White gelatine	15	grn.
Distilled water	2½	drm.
Sherry wine	18	oz.

Detannate in the manner directed above; then add—

Simple syrup	6	oz.
Tincture of cinchona	6	oz.

After eight days, filter.

May also be made with red wine, or direct from the bark, the quantities being—

Gelatine	15	grn.
Distilled water	2½	drm.
Sherry wine	30	oz.
Cinchona bark, in coarse powder	10	drm.
Sugar	1½	oz.

Macerate for eight days, and filter.

In this case, care must be taken to have the gelatine and wine reaction complete before adding the cinchona; otherwise the alkaloid may be thrown out by the tannin of the wine.

Improved Quinine Wine.—

Gelatine	15	grn.
Distilled water	2½	drm.

Dissolve, and add to—

Sherry wine	29½	oz.

Shake, and set aside to clear; then add the following solution:

Hydrochlorate of quinine	30	grn.
Dilute hydrochloric acid	30	drops.
Water	½	oz.

After a week filter.

This is double the strength given by Dieterich.

To Mellow Wines.—Cover the orifices of the vessel containing it with bladder closely fastened, instead of the usual materials, and an aqueous exhalation will pass through the bladder, leaving some fine crystallizations on the surface of the wine, which, when skimmed off, leaves the wine in a highly improved state of flavor. Remnants of wine covered in this manner, whether in bottles or in casks, will not turn mouldy as when stopped in the usual way, but will be improved instead of being deteriorated.

British Red Moselle.—Malmsey, colored with clarified elderberry juice.

British Sparkling Moselle.—From rich cider apples (carefully peeled and garbled), pressed with one-fourth of their weight of white magnum bonum plums (previously stoned), and the juice fermented with 2½ lb. double refined sugar per gal., as champagne.

Mould. See *Management of Wine*, on page 615.

Mulberry.—1. Juice of the fruit, 10 gal.; or of mulberries, bruised, 15 gal.; water, 15 gal.; sugar, 35 gal. Boil and ferment, then add spirit, 2 or 3 gal.; red tartar, 7 oz.; cassia, ½ oz.; bitter almonds, ½ oz.

2. Ripe mulberries, ripe apples, equal quantities; sugar or honey, 1 lb. to the gal. Express the juice, put it into a cask, and add the sugar. Ferment with yeast, 1 qt. to every hhd.; catechu, ½ lb.; red argol, ½ lb.

Mulled Wine.—Take ¼ oz. bruised cinnamon, ½ nutmeg, grated, and 10 bruised cloves. Infuse them in ½ pt. boiling water for an hour, strain, and add ½ oz. white sugar. Pour the whole into 1 pt. hot port or sherry wine. This is a good cordial and restorative in low stages of fever, or in the debility of convalescence from fevers.

British Muscatel.—As British sparkling moselle, with some infusion of clary, or of the musk plant, to flavor it.

Orange Wine.—The oranges must be perfectly ripe. Peel them and cut them in halves, crosswise of the cells; squeeze into a tub. The press used must be so close that the seeds cannot pass into the must. Add 2 lb. white sugar to each gal. sour orange juice, or 1 lb. to each gal. sweet orange juice, and 1 qt. water to each gal. of the mixed sugar and juice. Close fermentation is necessary. The resultant wine is amber colored, and tastes like dry hock, with the orange aroma. Vinegar can be made from the refuse, and extract from the peels.

Peach, to Make.—Take of cold soft water, 18 gal.; refined sugar, 25 lb.; honey, 6 lb.; white tartar, in fine powder, 2 oz.; peaches, 60 or 80 in number. Ferment, then add 2 gal brandy. This will make 18 gal.

The first division is to be put into the vat, and the day after, before the peaches are put in, take the stones from them, break them and

the kernels, then put them and the pulp into the vat.

Pepsin Wine.—

White gelatine, in strips ..... 15 grns.
Distilled water ..... 2½ drm.
White wine ..... 25 oz.

Detannate as described. At the same time mix together—

Pepsin ..... 7 drm.
Glycerine ..... 6 drm.
Distilled water ..... 6 drm.

Add to the wine along with 40 min. of hydrochloric acid; macerate for eight days, shaking occasionally; then filter.

Port.—

1. Ripe fruit ..... 4 lb.
Clear soft water ..... 1 gal.
Sugar ..... 3 lb.
Cream tartar dissolved in boiling water ..... 1½ oz.
Brandy ..... 2 to 3⅛.

Flavoring as required.

The addition of an equal quantity of fruit and sugar increases the strength.

2. Add to 10 gal. prepared cider, 2 gal. genuine port wine; 2 qt. best cognac brandy; 1 pt. simple syrup; 1 lb. bruised raisins; 1 oz. tincture kino; ½ oz. extract rhatany; 3 qt. proof spirits. Allow it to stand for two weeks, rack, fine and repeat if necessary. Keep the wine cool.

3. British Port, London Port, Southampton Port.—

Red Cape ..... 2 gal.
Damson or elder wine ..... 1 gal.
Brandy ..... ½ pt.
Powdered kino ..... ½ oz.

4. Strong old cider ..... 6 gal.
Elderberry juice ..... 4 gal.
Sloe juice ..... 3 gal.
Sugar ..... 28 lb.
Powdered extract of rhatany ..... 1 lb.
At time of racking add brandy ..... ½ gal.
Good port wine ..... 2 gal.

5. Good port, 12 gal.; rectified alcohol, 6 gal.; French brandy, 3 gal.; strong rough cider, 42 gal.; mix in a well sulphured cask.

6. Port wine, 8 gal.; brandy, 6 gal.; sloe juice, 4 gal.; strong rough cider, 45 gal.; as the last.

7. Cider, 24 gal.; juice of elderberries, 6 gal.; sloe juice, 4 gal.; rectified alcohol, 3 gal.; brandy, 1½ gal.; powdered rhatany, 7 lb.; isinglass, 4 oz.; dissolved in a gallon of cider; bung it down; in three months it will be fit to bottle, but should not be drunk until the next year; if a rougher quality is required, the quantity of rhatany may be increased, or alum, 5 or 6 oz. (dissolved in water), may be added.

Quinine Wine.—Break into small pieces 1 oz. of sulphate of quinine, and put it in a glass jar with 2 oz. of 90¢ Alcohol; let the quinine infuse for twenty-four hours; add 1 qt. of claret, and let it remain thus for twelve days; then filter the wine through a felt bag, and bottle for use. The above quantity of quinine may be dissolved, without the addition of alcohol in any of the following wines: Medeira, Marsala, Malaga, Lunel, or Alicant.

Racking Wine. See *Management of Wine.*

Red Wine.—

Cider ..... 16 gal.
Honey ..... 27 lb.
Tartar (red) ..... 8 oz.
Raw sugar ..... 3 lb.
Sliced red beet ..... 6 lb.

Boil, ferment, add—

Cassia ..... ½ oz.
Ginger ..... ½ oz.
Spirit ..... 5 qts.

Ripening of Wine. See *Manamagement of Wine.*

Ropiness of Wine. See *Management of Wine.*

Senna Wine.—

Alexandrian senna leaves ..... 1½ oz.
Sherry wine ..... 27 oz.

Macerate for eight days, press and strain; then add 5 grns. of gelatine dissolved in 2½ drm. of distilled water, and then the following:

Tincture of orange peel ..... 1 oz.
Tincture of ginger ..... ½ oz.
Aromatic tincture ..... 80 min.
Honey ..... 2 oz.

Again allow to stand for ten days, and filter. This wine is an excellent aperient for persons suffering from hemorrhoids. It should be taken in tablespoonfuls, according to the effect desired.

Sherry Wine.—1. To 8 gal. prepared cider add 6 qt. best sherry wine; 1 gal. native wine; ¼ drm. oil bitter almonds cut in ½ pt. alcohol; 3 gal. proof spirits; 1 lb. sugar; saffron to color. Let the wine stand for ten days, rack and fine.

2. Cape or raisin wine slightly flavored with a very little bitter almond cake, or, what is more convenient, a little of the essential oil dissolved in alcohol (essence of bitter almonds). —3. To the last add a minute quantity of sweet brier, eau de fleurs d'oranges, or orris, to give it a very slight bouquet.—4. To each gal. of strong raisin most, add, when racking, 1 Seville orange and 2 bitter almonds, both sliced. By omitting the almonds, and adding 2 or 3 green citrons to each 10 gal., this forms British Madeira:

5. Loaf sugar ..... 32 lb.
Sugar candy ..... 10 lb.
Water ..... 16 gal.

Boil, add pale ale wort (as for Madeira), 6 gal.; yeast, 1 lb.; on the third day add raisins, stoned, 10 lb.; and in another two or three days brandy 1 gal.; bitter almonds, grated, 1 dr.; bung it down for four months, draw it off into another cask, add brandy 1 gal., and in three months bottle it.—6. Teneriffe, slightly flavored with cherry laurel or almonds, forms a most excellent British sherry, either alone or diluted with an equal quantity of Cape or raisin wine.

Sour Grapes, Sherry Wine from.—The way an imitation sherry is made in England is to mix equal quantities of new cider and honey, and evaporate to a density so that a fresh egg will float so as to be half immersed. The liquid is then cooled and kept in a stone vessel at a temperature of from 60° to 67° Fah., until in about twelve or fourteen days the peculiar smell of the fermentation is strongly established; then the liquid is put into a barrel, closed up, and placed in a cool cellar to settle; after three or four days it will be cleared; it is then bottled, and six weeks later is fit for drinking. We believe that grape juice may be used in place of cider; but if too acid, sugar and water would only make a kind of lemonade.

and spoil the sherry taste, which is not acid. Sugar does not destroy this, but sulphite of lime is the proper material (not sulphate).

Scurness in Wine, to Correct a Bad Taste and Sourness.—Put in a bag the root of wild horse-radish cut in bits. Let it down in the wine and leave it there two days; take this out and put in another, repeating the same till the wine is perfectly restored. Or fill a bag with wheat; it will have the same effect.

Sour Wine, to Restore.—1. Take calcined gypsum, in powder, 1 oz.; cream of tartar, in powder, 2 oz.

Mix them in a pint or more of brandy; pour it into the cask; put in, also, a few sticks of cinnamon, and then stir the wine without disturbing the lees. Bung up the cask next day.

2. Boil 1 gal. of wine with some beaten oyster shells and crab's claws, burnt into powder, an ounce of each to every 10 gal. of wine; then strain out the liquor through a sieve, and when cold, put it into wine of the same sort, and it will give it a pleasant, lively taste. A lump of unslaked lime put into each cask will also keep the wine from turning sour.

Strawberry Wine.—Take of cold, soft water, 7 gal.; cidar, 6 gal.; strawberries, 6 gal. Ferment. Mix raw sugar, 16 lb.; red tartar, in fine powder, 3 oz.; the peel and juice of 2 lemons; then add brandy, 2 or 3 qt. This will make 18 gal.

Another.—Take of cold, soft water, 10 gal.; strawberries, 9 gal. Ferment. Mix raw sugar, 25 lb.; red tartar, in fine powder, 3 oz.; 2 lemons and 2 oranges, peel and juice; then add brandy, 1 gal. This will make 18 gal.

To Sweeten Wine.—In 30 gal. of wine infuse a handful of the flowers of clary; then add 1 lb. of mustard seed, dry ground, put it into a bag, and sink it to the bottom of the cask.

Tartaric Acid in Wine, Detection of Free.—Professor Claus evaporates to a syrup and agitates with ether. If free tartaric acid is present, the ether leaves, on evaporation, a crystalline deposit, which, if dissolved in water, gives, on the addition of an alcoholic solution of potassic acetate, a precipitate of tartar. The author proves the solubility of tartaric acid in ether, which is denied in most text books.—*Polyt. Notizblatt.*

British Tokay.—To good cider, 18 gal., add of elderberry juice, ½ gal.; honey, 28 lb.; sugar, 14 lb.; red argol, in powder, 3½ lb.; crystallized tartaric acid, 3 oz.; mix, boil, ferment, and, when the active fermentation is complete, add of brandy, 1 gal., and suspend in the liquid from the bunghole a mixture of cassia and ginger of each, ½ oz.; cloves and capsicum of each, ¼ oz.; the whole bruised and loosely inclosed in a coarse muslin bag. It will be ripe in 12 months.

White Wine.—

Cider	100	gal.
Honey	80	lb.
Sugar	20	lb.

Mix and ferment. Add 6 gal. spirit; white tartar, 1½ lb.; bitter almonds bruised, 1 oz.

Continued from page 2764

shade, grading off from one degree to another with perfect precision. After the plate has been exposed to the light a suitable length of time, with the negative or picture above it, on removing it from the frame there will be no indication whatever of a picture; but if a very fine black or brown fusible powder be dusted over the surface, it will bring out a fresh and accurate representation of the original image of extraordinary beauty and delicacy, becoming more and more distinct every moment in proportion to the continuance of the application of the powder. The bichromate may now be removed by washing with water, and the picture placed in an oven and fixed directly, or after having had a transparent coating of enamel laid upon it.

COLORED STARCH.

A new article for the laundry has recently been introduced into Europe, and has found much favor. It consists in a starch of different shades of color, by means of which any desired tint may be imparted to a dress in doing it up for a ball or party, and thereby enabling the owner to appear in sufficient variety of color without a corresponding number of dresses, as formerly. The most highly prized of these new starches is the crimson, which is readily prepared by dissolving three parts of fuchsine in twenty parts of glycerine, the fuchsine being first rubbed up in a mortar with a little water to a thick broth, and the glycerine subsequently stirred in. By this operation the fuchsine becomes completely dissolved without using any alcohol as a solvent. One hundred and fifty parts of finely rubbed up starch are to be stirred into the mixture in question, then dried and placed upon hurdles upon which unsized printing-paper had previously been spread out. To apply this in the starching of a white dress, the latter is to be first washed, and a portion of the starch treated with boiling water, as in the ordinary preparation of starch, and applied to the dress in the usual manner of starching. The dress is then to be dried, and after drying to be moistened a little, and ironed in the common way.

BLEACHING BY OIL OF TURPENTINE.

A German author recommends the use of oil of turpentine in bleaching white goods, to be applied by dissolving one part in three parts of strong alcohol, and placing a table-spoonful of the mixture in the water for the last rinsing. The clothes are to be immersed in this, well wrung out, and placed in the open air to dry. The bleaching action of the oil consists in its changing oxygen into ozone when exposed to the light, and in this process the turpentine disappears, leaving no trace behind.

ORGANIC MATTER IN WATER.

In a paper on organic matter in water Dr. Keisch states that the addition of a few drops of sewer water to cane-sugar solution starts a kind of fermentation, and when examined under a microscope the turbid liquid is found to be full of small spherical cells. Boiling does not seem to destroy the vitality of these organisms, filtration through a good bed of animal charcoal being the only effectual mode of removing them. It is, however, necessary to renew the charcoal from time to time, else it loses its purifying quality, and leaves the water as bad as before. These cells are quite peculiar in their character, and are not removed by filtering the water through the finest Swedish paper; and wherever they are found in water apparently pure in its source their occurrence may be directly referred to contamination by sewage water.

TEST OF ACTUAL DEATH.

A positive method by which real death may be distinguished readily from that which is apparent only has been for a long time a desideratum, and prizes of considerable value have at various times been offered for the announcement of some unerring test to determine between the two. Among others proposed for this purpose is the application of a few drops of a solution of belladonna to the eye. If life be present, in a few moments a dilatation of the pupil will be observed, very easily noted in comparison with the other eye, which has not been so treated. This is so independent of the condition of the eye that it is even observable in case of complete amaurosis or of paralysis, and is appreciable when all the ciliary nerves have been cut; and it may even be noted upon an eye that has been removed from the orbit as long as muscular contractility remains. Whenever, therefore, its application produces no effect whatever upon the eye, we may assume that muscular contractility has ceased, and, consequently, that life has entirely passed from the body. A precaution is, however, necessary in cases where dilatation has already taken place to the full possibility of the iris, which sometimes occurs in a case of apparent death, particularly when caused by the use of belladonna. A counteraction is therefore necessary in this instance, which is to be effected by means of the Calabar bean, which, if life be still present, will cause the pupil to contract.

CHLORIDE OF ZINC AS A PAINT.

Chloride of zinc, which has been used to advantage as a cement, is now highly recommended as a paint. A convenient application for this purpose is made by stirring a mixture of oxide and chloride of zinc in cream of tartar, adding starch enough to bring it to the proper consistency, and then boiling the whole and allowing it

to cool. If the paint is to be colored in any way, a pigment of the desired shade of color is to be introduced before boiling with the starch. In the course of half an hour the paint becomes dry and hard, in consequence of the formation of oxychloride, and the drying would be still more rapid if it were not somewhat retarded by the presence of the cream of tartar. This paint does not become darkened in the air, and is without smell; and even in winter, in consequence of its quick drying, will admit a second and third coat in the space of a few hours. It can be cleaned with soap and water, like an oil paint, and its action, in consequence of containing the chloride of zinc, is as a preservative of wood, rendering it almost incombustible—a peculiarity which can be increased by adding a small quantity of borax.

IRON SLAG CEMENT

A new form of cement, of much value, may, it is said, be prepared by finely pulverizing the slag of iron furnaces, and passing this through a fine sieve. This powder is then to be mixed in a mill with calcined gypsum, to which a variable amount of soluble phosphate of lime has been previously added. The best proportion of the different ingredients is said to consist of 700 parts of gypsum and 300 of slag, to which, for use in the open air, 28 parts of soluble phosphate of lime are to be added. This, however, may be replaced by a corresponding quantity, six to fourteen parts, of phosphoric or boracic acid, or any other substance capable of combination with the iron. The superphosphate of lime may also be substituted for the soluble phosphate. For this, however, an equal quantity of slag must be used. On the other hand, if the quantity of soluble phosphate of lime is increased, the sulphate may be entirely omitted.

It is always necessary to have the different ingredients finely pulverized and well mixed. When used, a sufficient quantity of water is to be added, and the whole thoroughly stirred together. With these substances blocks can be made as hard as marble, and capable of imitating this substance very closely. For this purpose the necessary moulds are to be laid upon a porous bed—gypsum, for instance—and subjected, by means of a screw or hydraulic press, to a great pressure. The cement, thus compressed, is removed from the mould in the form of a very hard block, which takes as fine a polish as marble, and may be stained or colored previous to the pressure in such a way as closely to resemble the different colors of this rock. This artificial marble resists the influence of air, moisture, and frost, and is said to be well adapted for the fronts of houses, floor tiles, etc.

TREATMENT OF WINE DURING FERMENTATION.

A method of preparing wine, so as to retain its bouquet and alcohol during fermentation, consists in placing the must, with the stems, in a vessel, closed by means of a lid, into which is inserted a tube ten inches long, and to the upper end of which is fastened a collapsed hog's bladder. After twenty-four hours the fermentation begins; the carbonic acid passes into the bladder and expands it considerably, the alcohol and the aroma remaining behind. After six or eight days the bladder collapses again, and the active fermentation is over, and the wine can then be drawn off, or left for a still longer time.

ECONOMY OF SEED IN PLANTING.

Experiments have recently tended to prove that roots and grains, by being planted much farther apart than is usual, will actually yield larger crops than are now obtained. This has been shown to be the case with potatoes, and more recently with wheat. It is found that the wheat plant increases above the ground in proportion as its roots have room to develop without interference with those of its neighbors. In one experiment, wheat thus treated furnished ears containing over one hundred and twenty grains. It was found, in the course of the same experiments, that on every fully developed cereal plant there is one ear superior to the rest; and that each ear has one grain which, when planted, will be more productive than any other. By selecting, therefore, the best grain of the best ear, and continuing the experiment through several generations, a point will be reached beyond which further improvement is impossible, and a fixed and permanent type remains as the final result.

CLEANSING FLUID.

A convenient preparation for taking out oil spots, and for cleansing articles of brass, silver-plated ware, and gold, is made by mixing together equal parts of caustic ammonia and spirits of soap; and this may be applied to a great variety of purposes in household economy.

INFLUENCE OF COLORED LIGHT ON INSECTS.

The discussion of the changes produced in animal and vegetable forms by the influence of varying conditions of temperature, moisture, light, locality, etc., especially as connected with the Darwinian hypothesis, has induced a great variety of experiments, from which some interesting results have been derived. In one of these experiments, lately published, a brood of caterpillars of the tortoise-shell butterfly of Europe was divided into three lots. One-third were placed in a photographic room lighted through orange-colored glass, one-third in a room lighted through blue glass, and the remainder kept in an ordinary cage in natural light. All were fed with their proper food, and the third lot developed into butterflies in the usual time. Those in the blue light were not healthy, a large number dying before changing; those raised in the orange light, however, were nearly as healthy as the first-mentioned. The perfect insects reared in the blue light differed from the average form in being much smaller, the orange-brown colors lighter, and the yellow and orange running into each other, instead of remaining distinct. Those raised in the yellow light were also smaller, but the orange-brown was replaced by salmon-color; and the blue edges of the wings seen in the ordinary form were of a dull slate. If changes so great as these can be produced in the course of a single experiment, it is probable that a continuance of the same upon a succession of individuals will develop some striking results.

NEW VEGETABLE FIBRES.

Among the recently discovered vegetable fibres, useful in the manufacture of cloth of various kinds, may be mentioned those of the China grass and the Ramie, both of them species belonging to the nettle family and to the genus *Boehmeria*. The China grass, when prepared, is of a brilliant snow-white color, and of remarkable fineness of fibre. Like the fibres of cotton, those of the China grass are single cells, some of which attain a length of eight inches, those of flax being at most only four. The Ramie is of still greater value in the arts, and is now extensively cultivated in the warmer portions of the United States, principally from seeds distributed by the Agricultural Department. This plant has been grown from time immemorial by the natives of the Indian Archipelago, and from the peculiarly water-proof nature of its fibre is used largely in the manufacture of nets. The plant is perennial and easily propagated by settings, yielding three or four harvests annually. The crop is about a thousand pounds of fibre per acre, of which about half is textile material, furnishing a silky, lustrous thread, longer than that of cotton. This is spun, mixed with either wool or cotton, and can indeed be worked by itself; in which case it has the appearance of Lyons silk.

ADULTERATION OF BEER.

According to a high German authority, beer is adulterated by a great variety of drugs and other substances, principally vegetable; some of which are harmless, while others are very injurious. These he classifies as, first, the bitter ingredients, intended to imitate the bitter taste of the hops; second, the bitter aromatic, also intended to reproduce the taste of the hop; third, the aromatic, meant to make the beer more stimulating; fourth, the sharp and aromatically sharp, to make the taste more piquant; fifth, the narcotic and sharply narcotic, to make the liquor more stupefying. Among the substances are mentioned opium, belladonna, henbane, tobacco, ignatius bean, cocculus indicus, etc.; all of which are more or less poisonous and reprehensible.

NORWEGIAN COOKING APPARATUS.

It is now several years since the so-called "Norwegian Cooking Apparatus" was first exhibited to the public; but it has since become a favorite in every direction, in consequence of the very great economy of fuel resulting from its use.

In its simplest form it consists of a square box or chest, lined at the bottom and sides with felt, and with a square plug of the same material, which can be laid on and the lid then shut down. Tin or iron vessels, containing the substance to be cooked, are first exposed over a fire for a short time to a certain amount of heat, and the substances in them brought to the boiling temperature. They are then taken off and set inside of the felt-lined box, the top is put on and the lid closed, and they are allowed to remain any desired length of time. The felt is so poor a conductor that the temperature of the vessels will be maintained for many hours almost unchanged, and the process of cooking will go on without interruption or the application of additional heat.

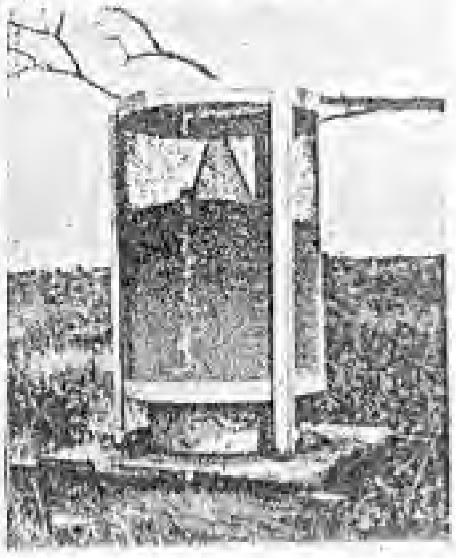
In one experiment a piece of beef was boiled with some potatoes for about seven minutes in a tin vessel, which was then placed in the chest and allowed to remain for a little longer time than would be required in ordinary cooking. On removing the vessel the contents were found perfectly done and smoking hot; and they probably would have retained the same temperature many hours longer, as after the lapse of five hours the vessel was so hot that the hand could not be held upon it.

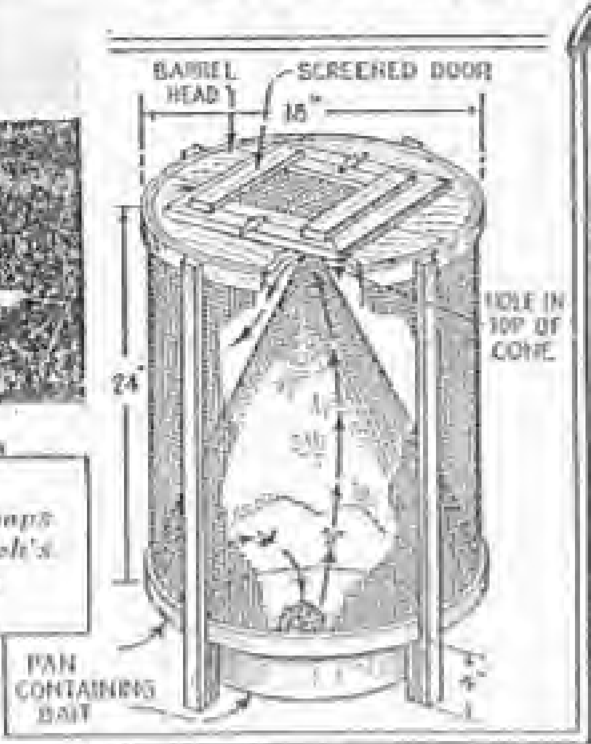
NEW INDICATION OF LONGEVITY.

According to Sir Duncan Gibb, the probable longevity of an individual may be determined by examining the position of the epiglottis. If this be found to be vertical, a great age may be looked for; if it is drooping or pendent, then the age of seventy is not likely to be reached, or, at any rate, exceeded.

We are not informed whether any apparatus or operation has yet been devised by which the healthy position of the epiglottis may be produced, and an increased longevity thus assured!

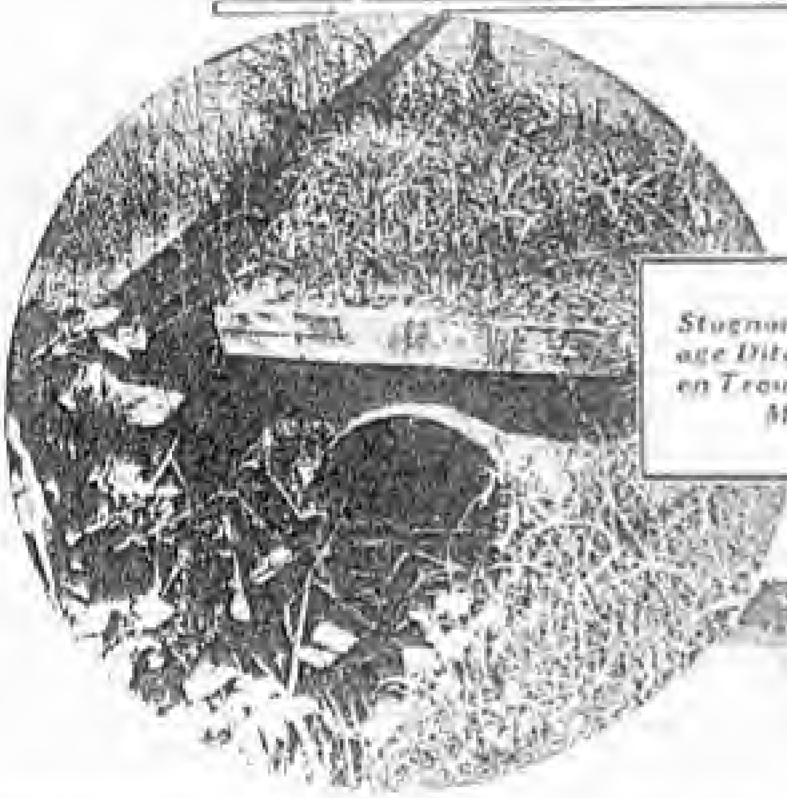
Ridding the Home

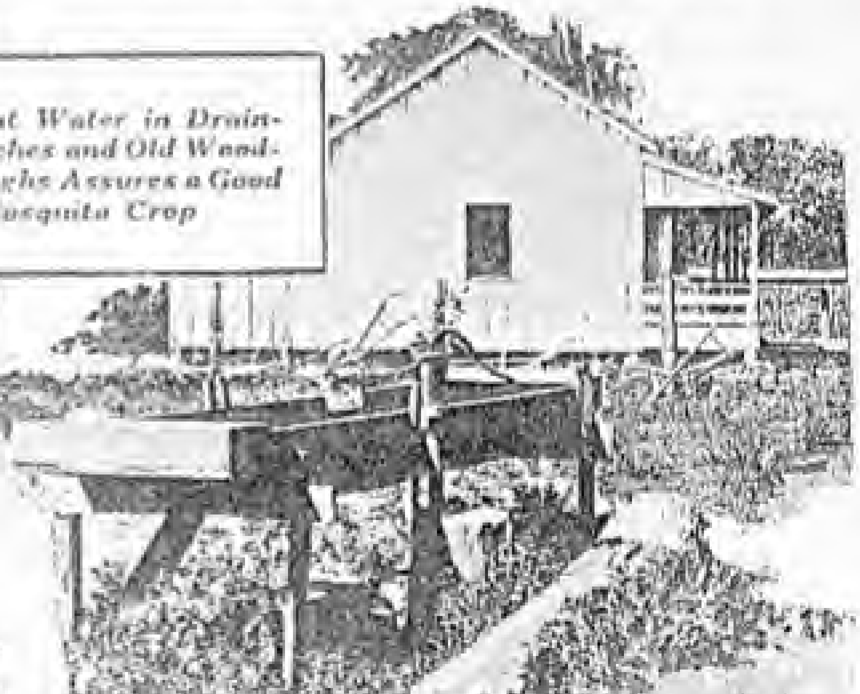




Flytrap of Barrel Hoops and Screen with a Week's Catch on a Farm

Take 2 lbs. of rosin and 1 pt. of castor oil; heat together until it looks like molasses. Take an ordinary paint brush and smear while hot on any kind of paper. A cheap and convenient fly poison is made by adding three teaspoonfuls of commercial formalin to a pint of milk sweetened with a little brown sugar. Partly fill a tumbler with the solution; cut a piece of white blotting paper to proper size and place in a saucer or plate. Place this over the glass and quickly invert the whole, inserting a toothpick under the edge of the glass. As the solution evaporates, the supply is automatically renewed from the glass.





Stagnant Water in Drainage Ditches and Old Wooden Troughs Assures a Good Mosquito Crop

Illustrations by Courtesy of the U. S. Department of Agriculture

BESIDES being an annoyance, the ordinary house fly is a menace to health through its ability to spread disease germs. Its presence is always an indication of unsanitary conditions and improper disposal of the substances in which it breeds, and its extermination becomes a community rather than an individual undertaking. Absolute cleanliness and the proper disposal of garbage and animal excreta would eliminate the fly in a short time. However, by the use of screens, poisons, fly paper and traps, a person can keep his own home comparatively free from this pest. A dozen sheets of sticky fly paper may be made for one cent by the following formula, prepared by the Kansas state board of health:

An efficient and durable flytrap may be constructed for about 75 cents. Details are shown in one of the drawings. Two barrel hoops are bent into a circle 18 in. in diameter on the inside and nailed together, the ends being trimmed to give a close fit, to form the bottom of the frame. Two other hoops similarly treated form the top. The top of the trap consists of a barrel head with the bevel edge sawed off so that it will fit tightly into the hoops. A 10-in.

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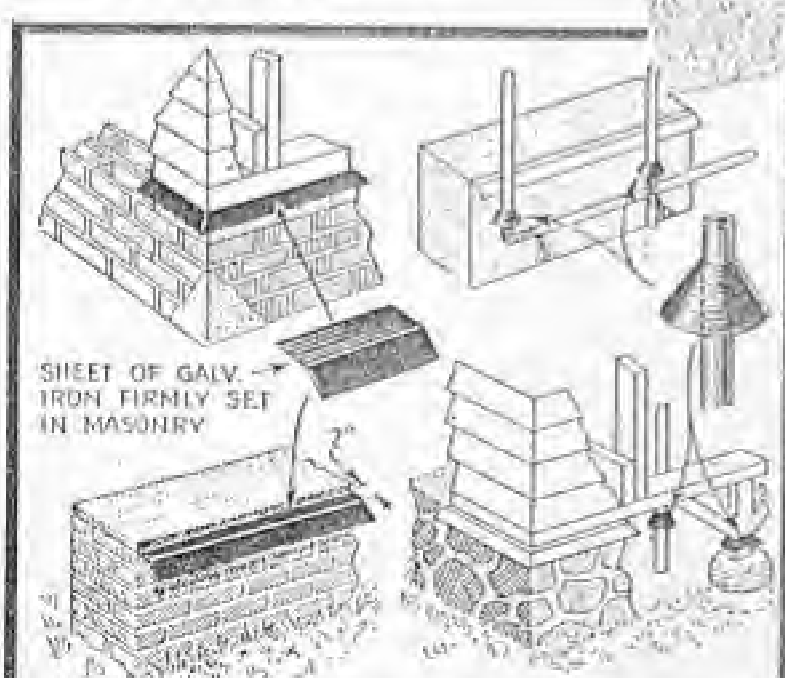
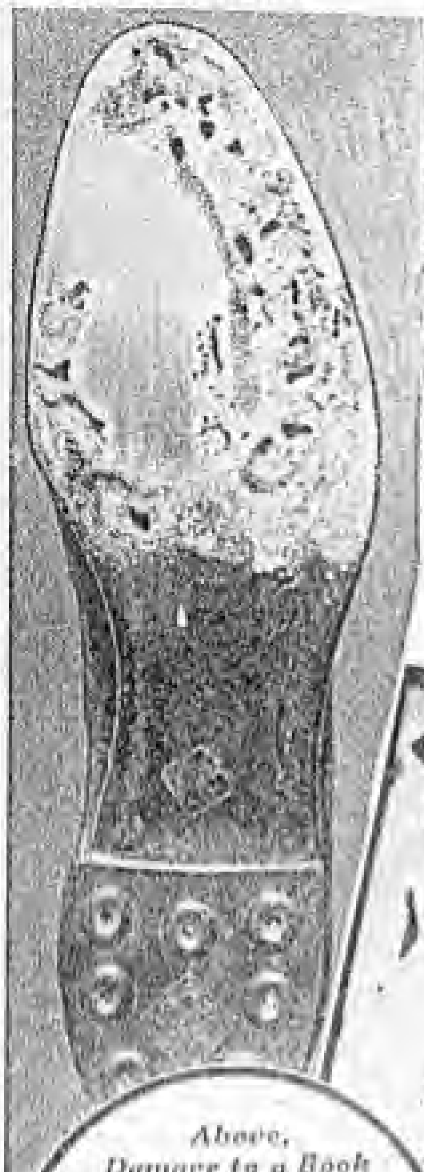
square, cut in the center, forms the door. Wood strips, 1 in. wide, nailed ½ in. from the opening, hold the barrel top together and form the door jamb. The door is a narrow frame covered with screen and well fitted into the jamb, where it is held in place by two turnbuttons. The top is nailed inside the top hoops, and the sides are formed by tacking screen on the outside of the hoops. It will take 61 in. of screen 24 in. wide to cover the sides, which are supported by four laths nailed to the hoops outside the wire. The laths project 4½ in. below the bottom hoops to form the legs. The cone is cut from a piece of screening 41 in. long by 26 in. wide. It is best to make a pattern of heavy paper before cutting the wire. The overlapping edges are soldered together and the apex is cut off the cone to give an opening one inch in diameter, after which the cone is inserted in the frame and closely tacked to the lower hoop. To bait the trap, fill a shallow pan about 14 in. in diameter with a solution consisting of one part of molasses and four parts of water. Place a sponge or a few chips in the center of the pan so that more flies will have room to feed, and place the pan under the trap. The trap should be placed where flies naturally congregate and the pan kept well filled with bait. Empty the trap weekly after immersing it in hot water to destroy the flies.

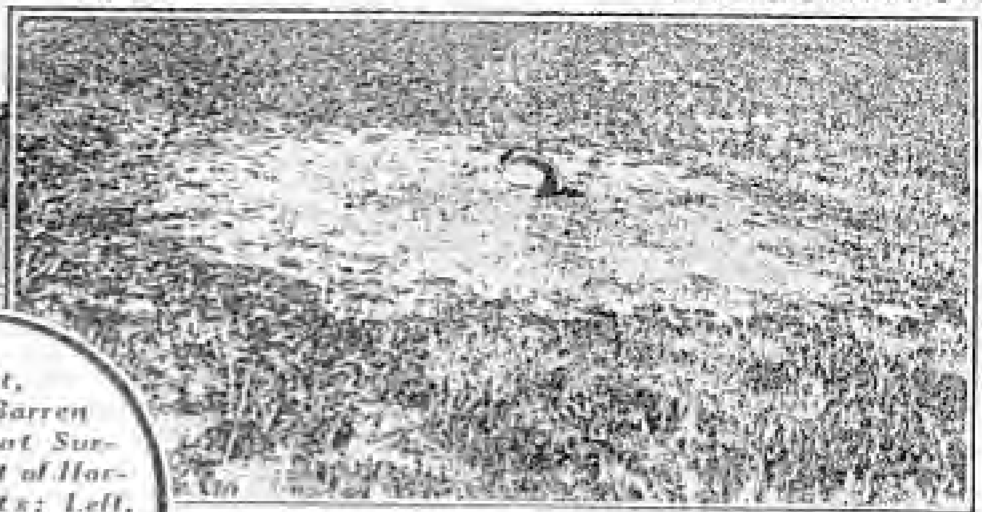
Argentine Ants Poisoned in Simple Tin-Can Traps; Birds and Animals Cannot Get at Them

Above, Ring of London Purple, Correctly Used, to Exterminate Red Harvester Ants

Right, Close-Up of Shelter Tube Constructed by Termites to Bridge Masonry So They Can Get at Wood; Below, Types of Sheet-Metal Shields That Protect Buildings against Termites







Right, Typical Barren Spots That Surround a Nest of Harvester Ants; Left, Termites Have Eaten Up through a Floor to Get at This Shoe

Above, Damage to a Book Which Was Caused by Termites; Right, This Was Once a Fur Helmet but Moth Larvae Have Eaten Off all the Fur; Below, Ready to Moth-proof Contents of Trunk with Chemicals

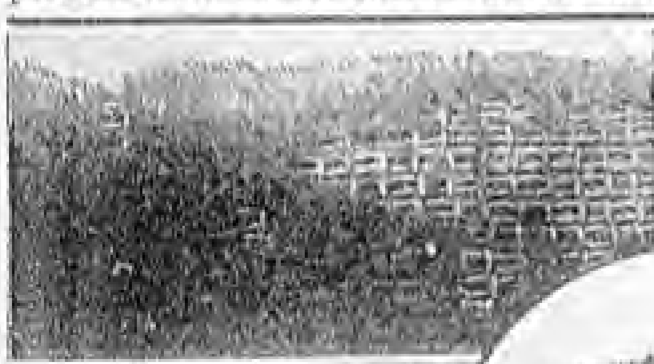
Effective Method of Using Carbon Tetrachloride to Keep Moths Out of Trunks and Closets; This Chemical, Obtainable at Any Drug Store, Is Non-Inflammable and a Quantity Is Poured into a Shallow Dish Placed in the Trunk or Closet, After Which the Latter Is Tightly Sealed; upon Evaporating, the Fumes of the Chemical, Being Heavier Than Air, Will Permeate the Clothing

The eradication of mosquitoes is also a community project, for until breeding places have been abolished, any efforts to keep the insects out of the home must be continuous during the summer. Mosquitoes lay eggs in still water. When these hatch the larvæ swim about in the water, but must come to the surface to breathe. Marshes, ponds, pools of rain water, hollow trees, rain barrels, roof gutters, tin cans, bottles, in fact any hollow receptacle that will hold water a few days will serve as a breeding place. To eradicate this pest marshes must be drained. Lakes and ponds must be oiled or stocked with minnows. In the latter case, vegetation must be trimmed closely around the edges so that the minnows can reach every portion of the surface. Casual pools of water should be sprayed with oil, roof gutters should be examined to see that they are not clogged, holes should be punched in cans before they are discarded, and water should not be allowed to stand

By Folding a Rug or Carpet Carefully to Inspect It, the Presence of Moth Larvae May Be Determined

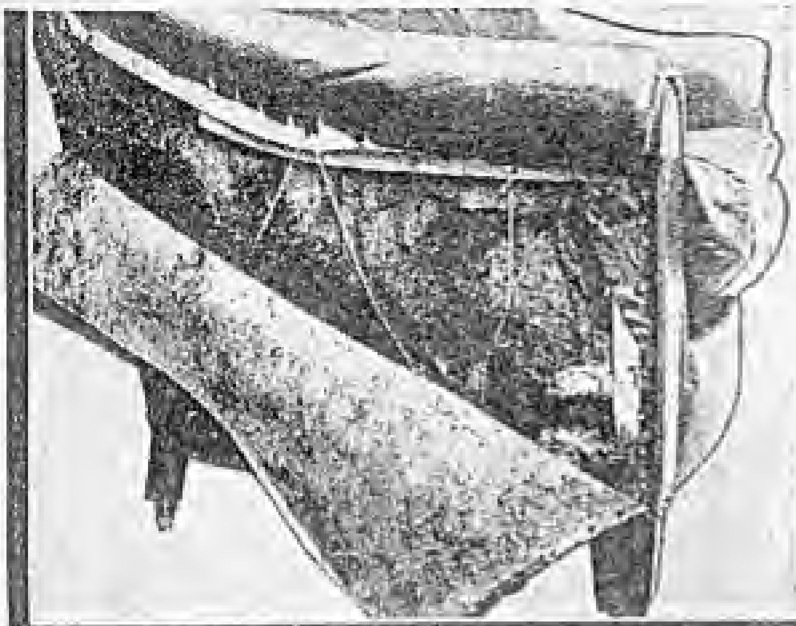
undisturbed in any receptacle for more than a day or two at a time.

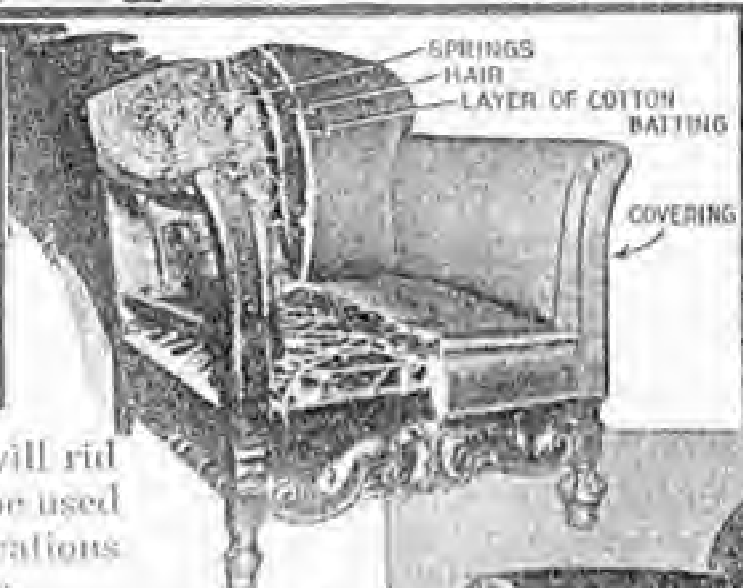
Tightly fitted screens, 18 meshes to the inch, will keep out most mosquitoes. Lightly painting the screens with kerosene or oil of citronella will prevent any from making their way through. Pyrethrum powder, moistened and heaped into a little pyramid, will burn slowly, and the smoke will stupefy any mosquitoes in the room if the air is fairly still. A little of the powder placed on a metal screen above the chimney of a kerosene lamp is even better. To rid a house of mosquitoes, one pound of powder must be burned for every 1,000 cubic feet of space. A solution of one part oil of cedar, two parts spirits of camphor and two parts oil of citronella, if rubbed on the face and hands, will keep mosquitoes away for several hours. A few drops of the solution placed on a bath towel hung over the head of the bed will enable a person to get some sleep in a mosquito-infested room. A little moist toilet soap, rubbed gently on a mosquito bite, will soon relieve the irritation.

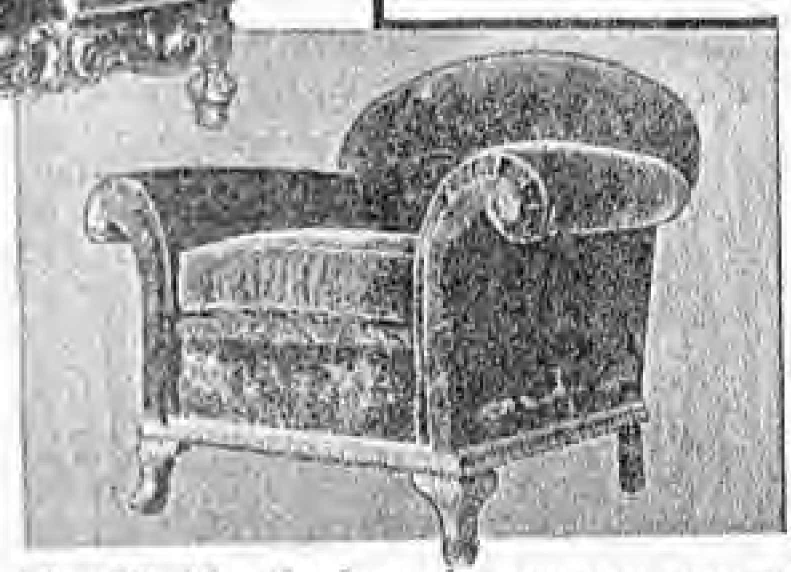


Above, Damage to Rug Caused by Moths: Right, Some Brushes Make Good Breeding Places for Moths; Below, Even Feathers Are Not Immune

House ants are attracted by food, especially meat, bread, cake, sugar and sirup. Keeping all food in ant-proof containers and ice boxes, and promptly cleaning up all crumbs after meals, will do much to abate the nuisance. Sodium fluoride powder, mixed with flour and dusted in runways, will kill all ants coming in contact with it. Dusting this chemical is also the most effective way of combating roaches. A wash of common laundry soap, using ½







Above, Damage by Moth Larvae on Overstuffed Furniture; Right, Type of Construction That Keeps Out Moths; Below, Slip Covers Permitted Moth Larvae to Feed Unmolested in Darkness

lb. to a gallon of water will rid a lawn of ants. It should be used as a spray. Several applications usually will be necessary.

Argentine ants, which are small and dark brown, are found in scattered localities throughout the South. These pests are intolerable in badly infested places, even going so far as to cause homes to be vacated. They invade bed chambers and have attacked babies with serious results. A bite from their mandibles is extremely painful. The most effective means of combating this ant is with poisoned sirup. A special formula, prepared by the department of agriculture, consists of 9 lbs. of granulated sugar, 6 grams of crystallized tartaric acid, and 8.4 grams of benzoate of soda boiled slowly for 30 min. in 9 pts. of water. Allow this to cool. Then dissolve 15 grams of sodium arsenate (C.P.) in ½ pt. of hot water and let it cool. Add this solution to the sirup and stir well. Then add 1¼ lbs. of honey and mix thoroughly. The best containers for this poison are made from ½-lb. baking-powder tins having friction covers. Indent each can deeply on opposite sides and replace the cover. If kept in an upright position this container is weather-proof, and there is ample room between the top of the can and the cover to permit the entrance of the ants. Two gills of sirup to each can will last several months. A piece of sponge should be placed in the can, where it will float on top of the sirup and provide room for the ants to feed in large numbers. A piece of wire 6 in. long may be bent to form a handle that will permit the can to be hung on trees, fences or the walls of houses. These ants prefer to climb for their food.

The red harvester ant does not usually invade the home, but when it infests lawns it makes their use for recreational purposes almost impossible, for it invariably gets on people and bites and stings or both. It also attacks live stock and is especially annoying to cows, often reducing milk production. This ant may be identified by the large barren area around its nest. A ring of London purple, placed in a complete circle 1½ in. wide and not more than 2 in. from the entrance to the nest, is most effective. If the ring is too far from the entrance, the ants will shake off the powder before entering the nest. If it is placed directly over the hole, or the ring is too deep, the ants will dig another entrance. Three or four applications are usually necessary to exterminate a colony.

Complete insulation from the ground of all untreated woodwork is the only insurance against ravages of termites or white ants. Foundations should be of stone, brick, concrete, or of wood treated with coal-tar creosote. No sleepers, stringers, beams or porch supports of untreated wood should be in contact with the ground. When termites cannot gain access to wood

directly they often build shelter tubes over the face of stone, concrete or brick foundations. A sheet of galvanized iron, firmly inserted in the face of the masonry, will form a shield that will cut off the termites' connection with the ground. The metal should be allowed to project horizontally for 2 in. and should then be turned downward at an angle. When all wood is so insulated, termites in the building will die.

Fumes of burning sulphur are effective for killing bedbugs, but are likely to cause damage to wallpaper and fabrics. A pound of sulphur is needed for each 1,000 cu. ft. of space, and the building should be closed tightly for at least 6 hrs. The sulphur is burned in a dish which is placed in a larger one as a precaution against fires being started by overflow. Liberal applications of kerosene, applied with a brush to all crevices in walls, furniture and mattresses, are usually adequate with slight or recent infestations. Since the bugs and eggs are destroyed at temperatures of 113° Fahr., it is quite simple to rid the house of bugs in summer by turning the central heating plant to full blast on a hot day.

Upholstered Furniture Cleared of Moths by Spraying with Chemical Solution Which Is Non-Inflammable and Will Not Stain the Fabric; Subjecting the Furniture to a Continued Heat of 130° Fahr. for a Few Hours Will Kill Both Moths and Moth Larvae; an Electric Heater Enclosed in a "Tent" of Comforters Will Do the Trick

Frequent cleaning, brushing and exposure to sunlight of fabrics will do much to prevent damage by clothes moths. Clothing to be stored should be wrapped tightly in paper containing naphthaline crystals. Carbon tetrachloride will keep moths out of closets or trunks. Merely pour a little of the liquid into a shallow dish, place it on top of the trunk or closet shelf, then seal the door or lid. The liquid will evaporate, and being heavier than air it will sink and permeate all the clothing. Cedar chests give effective moth protection if only fabrics that have been cleaned recently and thoroughly are placed in them.

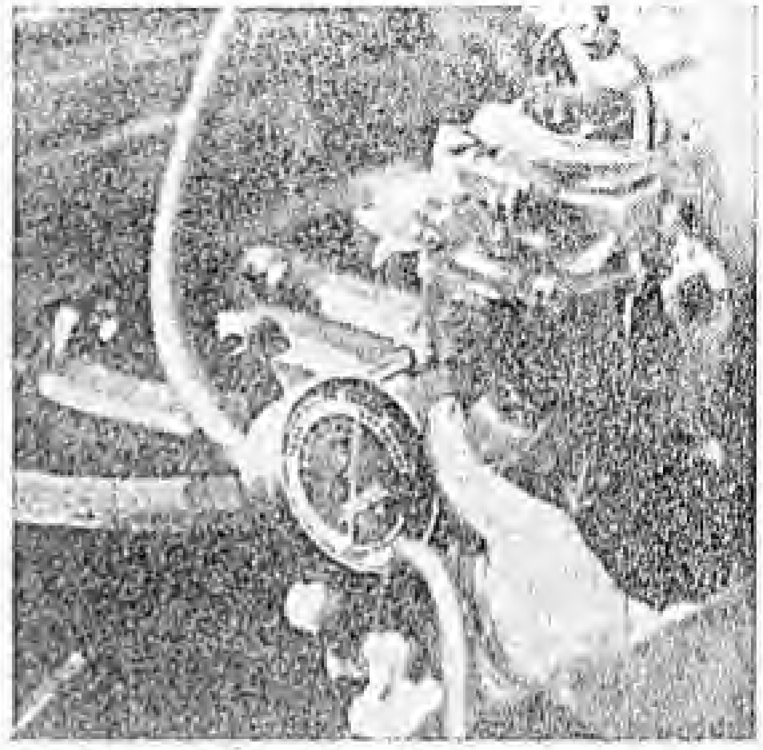
By maintaining a dry heat of 130° for an hour or more, so that all articles reach that temperature, all moths, eggs and larvæ in the home can be killed. This superheating, in fact, is one of the simplest and best ways of ridding a house of all pests during hot months.

Upholstered furniture which has become infested with moths may be cleared of them by spraying with a solution made by dissolving paradichlorbenzene, 1 part, in ethylene dichloride, 75 parts, and carbon tetrachloride, 25 parts. This solution is non-inflammable and will not leave a stain on the fabric. Paradichlorbenzene crystals placed in an open container on a clothes-closet shelf will keep moths away.

Is a tuneup worth $70? If done right, you bet it is, and you can do an equally good job on your car at home without hundreds of dollars worth of special tools—here's how to go about it

1001 How-To Ideas

2: CLEAN BATTERY POSTS and terminals with special wire brush (shown), an ordinary wire brush, or steel wool to increase current carrying ability.



3: FUEL PRESSURE TEST calls for vacuum-pressure gauge (about $6.50 at mail order or auto stores). Make test at fuel line where it connects to carb.

Tuneup at Home

roded, replace it with a new one.

These simple services alone have had black magical effects in many cases of hard starting.

(2) Torque the cylinder heads, carburetor mounting and intake manifold (Fig. 1). Eliminating compression losses and air leaks, present or potential, is another way to be sure of top performance. (Note: after torquing the head on cars with mechanical valve lifters, valve clearance should be checked, between the rocker and valve stem, with the valve fully closed. If it does not agree with specifications, adjust lash. Do this job after finishing all other work.)

(3) Test compression and renew or clean and gap the spark plugs.

(4) Fuel system:

Service the air filter. If it's the paper or polyeurethane type, replace—don't try to clean it.

Clean wire mesh and oil bath types. Wash element in solvent and reoil. Clogged air filters cut gas mileage, top speed and acceleration.

Check fuel pump pressure with a vacuum-pressure gauge (Fig. 3). If it is above or below specifications, replace the pump. Low pressure causes fuel starvation, high pressure flooding. And either condition worsens rapidly.

Note the position of the automatic choke plate with the engine cold. It should be in the fully closed position. Move the plate to be sure the shaft is not binding.

If the accelerator linkage is connected to the choke assembly, have someone floor the gas pedal—the choke should open ever so slightly. If it does not, adjust it or replace worn parts.

Remember to recheck the choke when the engine is at operating temperature—it should be fully open. To insure continued

5: AUTOMATIC CHOKE mechanism in carburetor is kept working by spraying inwards with solvent.

4: IN-LINE FUEL FILTER keeps grit out of carb and is an easy item to install or replace in fuel line.

Give your car a $70 tuneup at home to save $50 compared to the prices many specialty shops charge for work you can do as well in a single Saturday

free operation, spray the inside of the choke assembly with solvent (Fig. 5).

If the fuel system is equipped with an in-the-line pleated paper filter, replace it (Fig. 4). If it is not, run solvent thru the carburetor to clean it, using any of the special kits made for the job (Fig 6). Then install an in-the-line filter for long-term protection.

If the fuel pump has a sediment bowl, remove and clean it.

With the engine cold, free up the manifold heat control valve ("heat riser"), using a spray solvent such as the type used for cleaning automatic chokes (Fig. 8). If the valve is sticking only slightly, spray solvent on the shaft and turn the shaft (holding it by the counterweight) to work the chemical in.

If the shaft is stuck tight, hammer blows on the counterweight combined with solvent spray should free it eventually. Remember, the job isn't done until the shaft turns without a trace of binding.

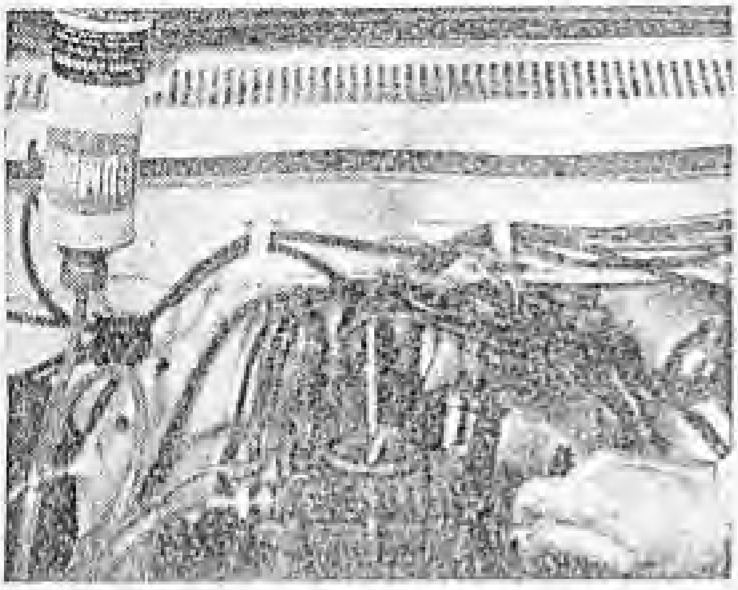
If the shaft resists all attempts to free it, the exhaust manifold will have to be removed and the valve assembly replaced. Stuck heat risers are a common cause of poor fuel mileage and performance.

(5) Ignition System:

When installing points, clean any dirt from the breaker plate.

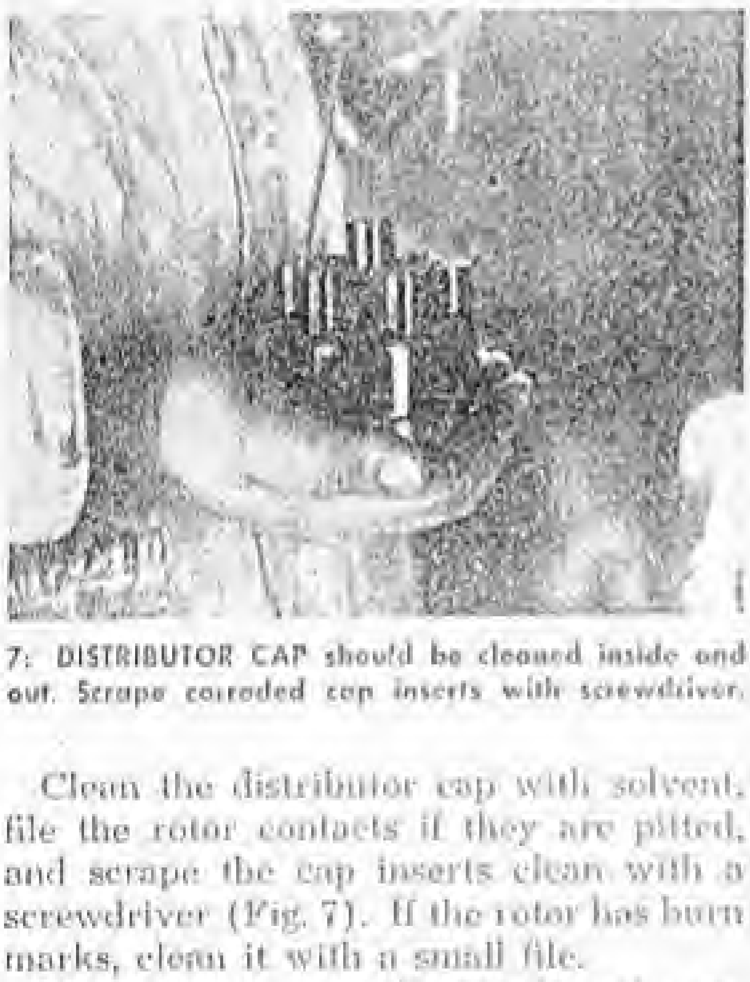
Check the mechanical advance. If it is on top of the distributor, check to see that the springs are connected properly and the mechanism operates freely. If it is under the breaker plate, turn the rotor in the direction of distributor cam rotation (Fig. 9).

Replace the vacuum advance, even if it seems to be functioning properly. One tuneup specialist remarked, "When the vacuum advance is more than a year old, you know the darn thing will start sticking soon. And when it does, you can go crazy trying to trace the trouble."



6: CARB CLEANING KIT removes gum from inside of unit without removing it or taking it all apart.

8: MANIFOLD HEAT CONTROL VALVE must turn freely. Solvent spray and hammer taps should unstick it.



7: DISTRIBUTOR CAP should be cleaned inside and out. Scrape corroded cap inserts with screwdriver.

9: CHECK MECHANICAL ADVANCE by turning rotor same way as cam; released, it should snap back.

Clean the distributor cap with solvent, file the rotor contacts if they are pitted, and scrape the cap inserts clean with a screwdriver (Fig. 7). If the rotor has burn marks, clean it with a small file.

Many tuneup specialists replace the external resistor on cars so equipped, just to be on the safe side. This job, however, is strictly an optional extra for the man who is doing the job himself.

Clean and tighten the primary ignition wiring connections (the thin wires at the coil, distributor and resistor).

Replace the rubber nipples on the spark plug and coil secondary wires, and the wires themselves, if they are cracked, oil soaked or rotted. If they are in good condition, coat with waterproofing spray.

Wipe the coil tower clean.

(6) Exhaust System:

Check the exhaust piping for any severe dents. A badly dented exhaust restricts gas flow and reduces power.

(7) Charging and Starting Systems:

Inspect the generator drive belt. It should deflect about ½-inch at a point midway between pulleys. If it's loose, tighten it. If it appears glazed on the inside, or ragged, replace it.

Electrical checks of the starter, generator and regulator require special equipment, and therefore must be left to the mechanic. In general, however, you can tell whether or not everything is okay by observation.

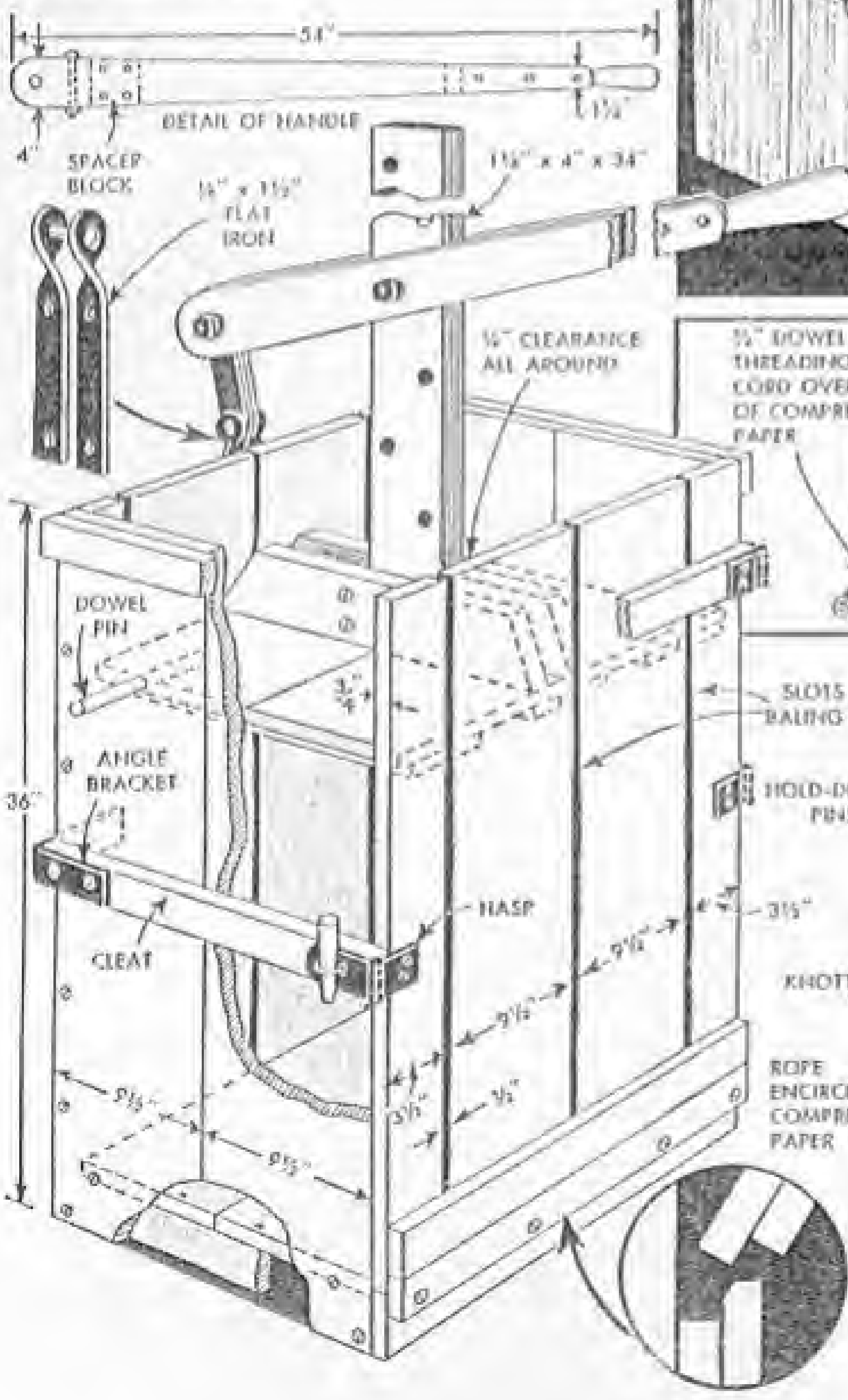
If the battery uses a normal amount of water, does not discharge in normal use, the charging system is apparently functioning properly. If the starter cranks vigorously with the battery at full charge, the starting system probably is okay.

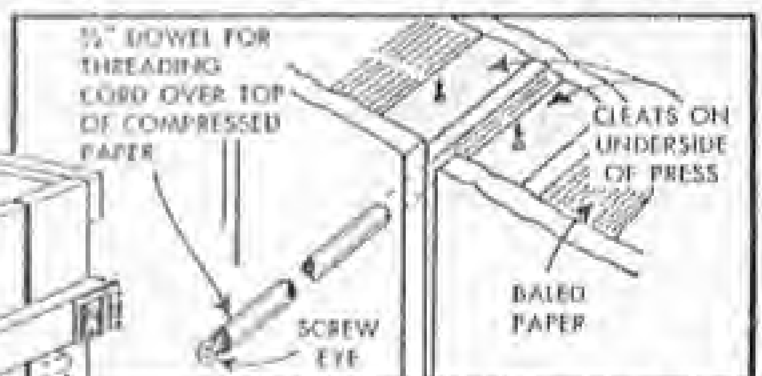
Quite obviously, this king-size tune-up will take the better part of a Saturday. But depending on how much and where you drive, it will give you from 6 months to a year of top performance. ■

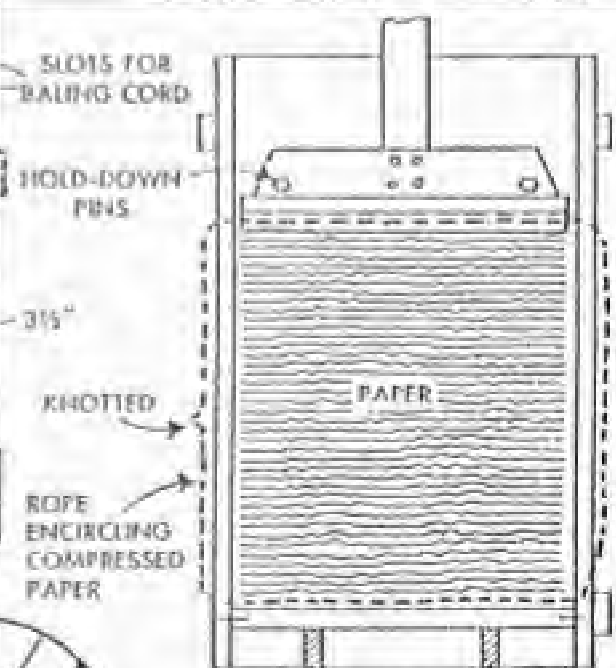
Bale your WASTE PAPER!

Popular Mechanics Aug. 1942

If you are saving waste paper, this inexpensive baler will enable you to compress it for easy handling and to take little storage space while waiting for the collector. Made from stock lumber, all sides of the baler are reinforced, and one side is held by staples and hasps so that it is easily taken off for removal of the paper bale. The plunger should have at least a ¼ in. clearance all around. Holes are drilled through opposite sides of the baler for the insertion of dowels, which hold the plunger in the compressed position while tying the baling cord in place.







SECTIONAL VIEW

Rope or cord is laid across the baler bottom before starting and then later brought up the sides and over the compressed paper, passing it between cleats under the plunger